DIRECTIONAL DRILLING SERVICES
Positive Down Hole Motors Brochures
CAVO Technology Method

DIRECTIONAL DRILLING SERVICES

POSITIVE DISPLACEMENT DRILLING MOTORS SERVICES

Since 1999, TLOS has had a long-term agreement by which DRILEX, (Dinmore Road-Bridge of Don-Aberdeen-AB23 8DZ-UK.) confirm its past and continuing co-operation, with Triple "L" Oil Services on projects in Egypt, United Arab Emirates, Sudan and Syria.

IN 2003, TLOS decided to have its own first generation of TL-Drill Motors designed to be consistent with the most recent technology and safety devices that furnish the maximum utility and life time in additions to cost effective operations to its customer.

TLOS signed a long-term agreement with one of the most experienced Design houses in USA CAVO. Mr. P.L. Perez the General Manager for CAVO Drilling Motors, (512 N. Sam Houston Pkwy E, Suite 640, Houston, TX 77060-USA) and Mr. M. El Assal for TLOS signed the agreement.

With the help of CAVO and other international bearing, AND Power sections Manufactures; the most advanced generations of "TL-Drill" down hole motors are now exists for our production and Exploration client and other service Companies.

Motors parts are manufactured and assembled to API specifications and use API Standard material Certificates are attached.

A wide range of sizes and specifications of Motors are suitable for all drilling environmental and formations requirements.
Triple-“L” offers a complete line of high quality "TL-Drill" motors specifically designed for directional drilling. TL-Drill directional motors are available for both water-based and oil-based drilling applications.

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Our directional motors include a high performance power section, dual safety catch devices, high performance transmission coupling, a simple and easy to use adjustable bend housing, a durable bearing assembly with Seal-Free Technology bearings, and a forged output shaft with integral bit box.

TL-Drill directional motors have a proven record of reliable operation and exceptional drilling performance.

The Triple "L" line of downhole motors are engineered to provide maximum performance at the bit. Motor speed and torque are transferred through a high speed articulated coupling down to a Seal Free bearing assembly. The Seal Free Bearing Assembly incorporates TC-matrix radial bearings for maximum wear resistance and full contact, bi- directional thrust bearings for peak load capacity. Power is transferred through a forged alloy steel drive shaft for maximum output torque.
Seal Free Technology Bearings offer the advantage of high drill bit differential pressure without the concern of losing seal integrity which is possible with typical sealed bearing motors.

Triple "L" downhole motors come equipped with upper and lower safety catch systems. This adds protection against leaving motor components in the hole in the unlikely event of a connection failure.

MOTOR OPERATION MANUAL

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TL-DRILL MOTORS

About Us

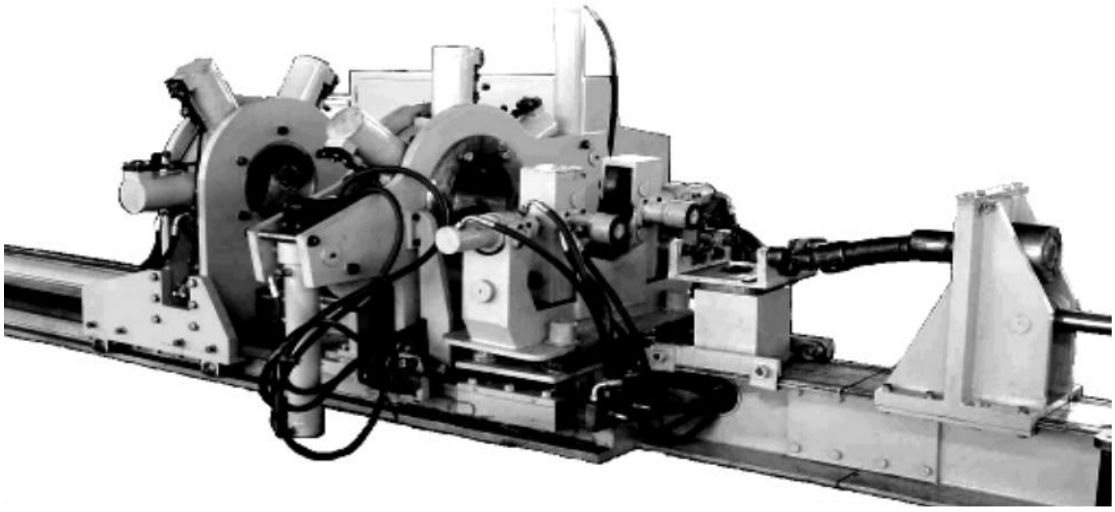
TL-DRILL Motors offers a complete line of quality down hole mud motors rangingfrom2-7/8”to11-1/4”ODfor use in drilling 3-1/8”to26” holes sizes. The goal of "TL-Drill" Drilling Motors is to provide the best in quality, Performance, and value. "TL-Drill" motors are manufactured through a dedicated facility that is both ISO and API certified. "TL-Drill" is one of a few companies that designs and manufactures its own multi-lobe power sections making "TL-Drill" a complete motor solutions provider.

"TL-Drill" is also a complete source for motor spare parts and components. This Includes rotors, stators, couplings, radial bearings, bearing assemblies, and stabilizers. "TL-Drill" has a staff of highly experienced personnel to provide technical assistance with issues concerning all aspects of drilling motor design, function, operations, and troubleshooting.

Quality is a backbone of our organization. We strive to bring the highest quality and reliable product to the market while maintaining the lowest possible cost. Our supplier manufacturing facility is ISO 9001 certified and holds a current authorized API monogram license. Providing quality drilling motor products to the industry is our highest priority.

Motor Service Center

"TL-Drill" Motors is more than just a motor and spare parts supplier.
"TL-Drill" offers the opportunity to establish an independent Drilling Motor Service Center (DMS Center).Complete onsite training in motor assembly, servicing, repair, and maintenance of the motors is available. "TL-Drill" also offers the service equipment to support and maintain the drilling motors, including the **"TL-Drill" Power-Auto Torque Service Unit** for complete motor servicing.



General Tool Description

The "TL-Drill" tool is a positive displacement motor. It uses the René Moineau principle which states that a helical rotor with one or more lobes will rotate when placed eccentrically inside a stator having one more lobe than the rotor. The rotor and the stator form a series of sealed cavities so that when drilling fluid is pumped into the tool the rotor will be driven in an eccentric rotary motion relative to the stator, allowing the fluid to pass while transmitting rotational power to the drive train and bit.

Torque and rotational outputs can be varied by employing different rotor/stator lobe configurations. In general, more torque will be generated by configurations employing greater number of lobes and number of stages.

The eccentric placement of the rotor in the stator causes the axis of the rotor to rotate about the axis of the stator. This movement acts as a gear reduction mechanism and causes bit speed to reduce as rotor/stator lobe configuration increase.

Motor Highlights

TL-DRILL motors have been engineered to have the following attributes:

•***Rotors:*** "TL-Drill" solid and bored rotors are precision machined and polished to achieve a smooth and accurate finish. Each rotor is then plated for corrosion protection and wear resistance.

•***Stators:*** "TL-Drill" stators use a quality high performance but a diene acrylonitrile elastomer. The "TL-Drill" elastomer is a versatile and field proven formulation. It has excellent mechanical properties and good resistance to aromatics. The "TL-Drill" elastomer has an operating temperature range up to 250°F (120°C) and a maximum temperature range to 350°F (175°C). Our elastomers are routinely inspected and tested to ASTM standards to ensure a quality stator product.

•***Safety Anti-drop Devices:*** "TL-Drill" offers two safety anti-drop devices in each motor to provide additional security against leaving motor components in the hole in the unlikely event of a connection failure.

•***Couplings:*** "TL-Drill" offer two types of coupling assemblies. The "TL-Drill" standard coupling is a classic and field proven connecting rod. Also available is a high strength ball drive coupling for extended performance. Both TL-DRILL couplings are precision made for smooth articulation and minimal wear while providing optimum torque to the bit.

•***Adjustable Bend Housing (ABH):*** "TL-Drill" offers adjustable bend housing with a 0 to 3 degree bend angle adjustment. The "TL-Drill" ABH is engineered for simple adjustment and ease of use at the rig site.

•***Bearing Assembly:*** The "TL-Drill" mud-lubricated bearing assembly is a robust and field proven design. "TL-Drill" uses a special tungsten carbide tile matrix for the radial bearings for maximum protection against radial wear. Axial thrust is managed by a series of full contact mud lubricated tool steel thrust bearings. Mud-lubricated bearings offer the advantage of providing higher differential pressures across the drill bit without the concern of losing seal integrity that is possible with sealed bearing units. The "TL-Drill" bearing assembly has a proven history of excellence in both performance and reliability.

DRILLING MOTOR INTRODUCTION

Since its introduction in 1956, the positive displacement motor has undergone revolutionary changes and improvements. Downhole drilling motors have proven to be successful in the most rigorous of drilling environments. Today, horizontal drilling, steerable systems, extended- reach drilling, and conventional directional drilling have all become routine. The technological advances in these various types of drilling operations have reduced drilling and production costs, and have significantly improved the odds of bringing in a successful well. The "TL-Drill" Drilling Motor product line is uniquely suited for many various drilling applications and conditions. The primary focus of this manual is to aid in explaining drilling applications, motor selection, and use of the motor. To enhance the understanding of drilling motor application, selection, and operation, we have included information on the following topics in this manual:

- Drilling Motor Application
- Drilling Motor Design
- Drilling Motor Operation
- Adjustable Bend Housing Operation
- Power Section Performance Factors
- Special Applications
- Motor Specifications
- Troubleshooting
- Fishing Dimensions
- Contact Information

Comprehensive motor performance curves, dimensional data, and operational data are included in the Motor Specifications section. It is our goal with this manual to offer effective solutions to your drilling challenges, by providing drilling motor information and reference data. Please read through this manual in its entirety. As always, the "TL-Drill" technical staff is available and committed to provide you any information needed to accompany this manual.

DRILLING MOTOR APPLICATIONS

Since the inception of rotary drilling more than 100 years ago, operators, drilling contractors, and service and supply companies have worked tirelessly to improve drilling technology. Their common goal has been to reach their drilling objective, in various drilling environments, quickly, efficiently, and at a reasonable cost so wells are productive and profitable. Since drilling targets have become more complex and more difficult to reach, delivering horsepower directly to the bit independent of rotating the drill string has become increasingly important.
The need for motors in different applications has led to the design of several different types of down hole motors. These motors are specifically configured to the drilling application for which they are needed. Typical applications and motors are presented in this section.

Conventional Applications

Typically, a low-speed, high-torque motor is used in conjunction with single-shot-survey orientation instrumentation and a bent sub. This type of motor is effective for kickoffs, course corrections, angle control, and side tracking. It provides low operating costs and easy maintenance.

Straight-Hole Applications

"TL-Drill" motors can be used over extended straight-hole drilling intervals. By turning the bit several times faster than the drill string, these motors effectively provide increased rate of penetration (ROP) and angle control under the adverse conditions found in many straight-hole applications. Compared to rotary drilling technology, Downhole motors offer intangible benefits that must be taken into consideration in the final cost/benefits analysis. These benefits include:

- Fewer round trips for BHA changes.
- Fewer hole problems, such as formations welling, formation caving, doglegs, key seats, and hole sloughing enabled by faster ROP and less open hole time.
- Minimized wear, tear, and fatigue of drill string components, surface pipe, and casing enabled by reduced drill string RPM.
- Reduction of drill string torque.
- Faster and smoother casing setting.

Directional Applications

"TL-Drill" offers steerable systems in which stabilized, bent-housing motors are used. The motor provides continuous bit rotation, while selective rotation of the drill string controls wellbore trajectory. Applications that are technically and economically feasible with these systems include:

- Wells that penetrate complex multiple targets.
- Horizontal wells that stay in narrow, dipping production zones.
- Vertical wells in formations with severe crooked hole tendency.

A "TL-Drill" motor is an ideal choice for the demands imposed by directional drilling. Our steerable motor can be matched with various types of bits, such as PDC, roller cone, or natural diamond.

Special Applications

A variety of "TL-Drill" motors are available for mining, geothermal drilling, coring, work over, milling, hole opening, and under-reaming, as well as for piling, casing, and template-drilling applications. Applications for "TL-Drill" small motors (3-3/4” OD and smaller) include the following:

•Drilling through sand bridges and cement plugs

•Cleaning out paraffin build-up

•Minerals exploration

•Horizontal boring

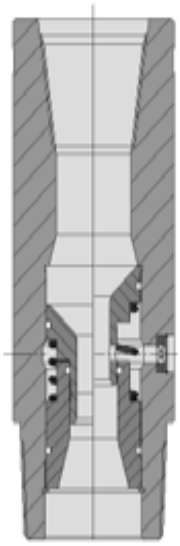
•Pilot-hole drilling.

DRILLING MOTOR DESIGN

The "TL-Drill" motor is a positive-displacement motor (PDM) through which drilling fluid passes as it is pumped down the drill string. The fluid flows through the downhole motor's progressive cavities, and the pressure of this fluid causes the rotor to rotate. Torque is then transmitted to the drill bit.
The TL-DRILL drilling motor is comprised of 5 basic components:

- Crossover sub (or optional dump valve)
- Safety Anti-drop device (optional)
- Power-section assembly
- Coupling assembly
- Bearing assembly

Dump Valve Assembly



In a standard motor setup, a crossover sub is used to connect the motor to the drill string. Optionally, a dump valve can be used instead of the crossover sub. The dump valve assembly enables the drill string to fill with mud from the annulus while tripping into the hole and enables the drill string to drain while tripping out of the hole. The valve uses a spring-loaded piston to close the ports separating the inside of the tool from the annulus surrounding the tool. When drilling fluid is not circulating, the spring holds the piston in the up, or open-port, position. This allows the fluid to enter or exit the drill string through the ports and bypass the motor.

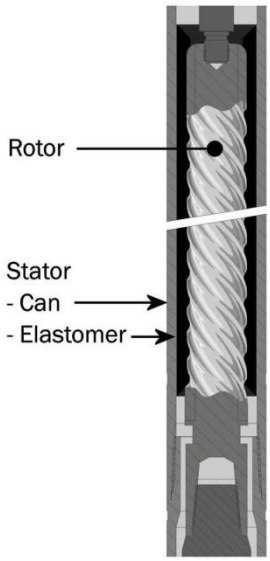
When the mud pumps are turned on, the circulating fluid creates a small pressure drop across the piston and an attendant force on the piston and spring. The pressure drop and the force increase as fluid velocity increases. As the circulating drilling fluid reaches the minimum velocity needed to overcome the spring force holding the piston in the up position, the dump valve is forced into the down, or closed port, position. The fluid then flows through the motor, providing horsepower to turn the bit. When the mud pumps are turned off and circulation ceases, the piston is forced back into the up(open) position, allowing drilling fluid to bypass the motor while tripping pipe.

Safety Anti-Drop Device

The safety anti-drop device is an optional component that provides the ability to remove the motor components including the drill bit in the unlikely case of a lower connection failure. It is generally used when tool joints are exposed to excessive loads from extreme drilling applications. The rotor safety catch device offers protection from possible fishing operations in the hole.

Power Section Assembly

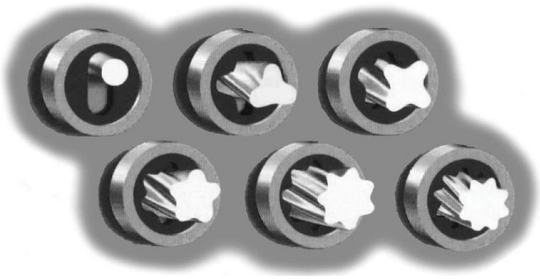
The power section is the portion of the motor that converts hydraulic horsepower into mechanical horsepower, resulting in drill-bit rotation. The power section consists of only two parts, the rotor and the stator. When assembled, these two components form a continuous seal along their contact points. The rotor is an alloy steel bar with a helical (multi-lobed) pattern. It is chromed plated to reduce friction, wear, and corrosion. Stainless Steel rotors or Tungsten Carbide Coated rotors are available, depending on the specific application and/or environment in which the motor is to be used. The rotors may have provisions for nozzle sand axial bores to bypass flow and extend the flow-rate ranges.



The stator is a length of tubular steel lined with an elastomer compound that is shaped with a helical pattern to mate with the rotor. Various elastomers are available, depending on drilling-fluid type and bottom hole temperature. High Temperature, High Pressure elastomer is also available.

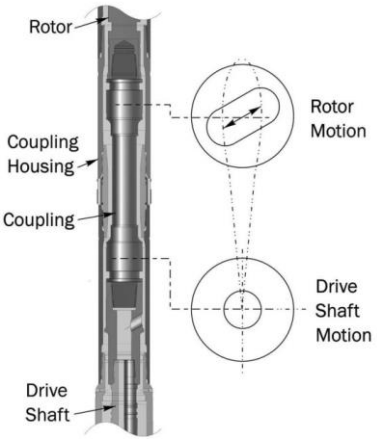
Motor Profiles

The power sections of "TL-Drill" motors are designed to provide various speed ranges. These speed ranges are achieved by varying the pitch and the rotor/stator lobe ratio. Generally, more lobes yield higher torque and slower speed while fewer lobes yield higher speed and lower torque. The number of stator lobes always exceed the number of rotor lobes by one - hence, the rotor/stator lobe-ratio designations of 5:6, 7:8, 9:10 etc.



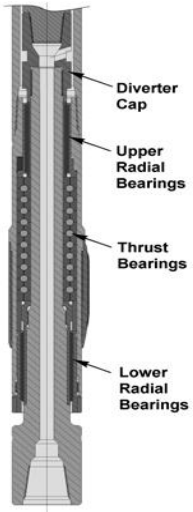
Coupling Assembly

The coupling assembly is attached to the lower end of the rotor and transmits motor rotational torque and speed to the drive shaft and bit. The coupling assembly converts the eccentric motion of the rotor to the concentric motion of the drive shaft.
Additionally, the flexible coupling allows for placement of a bend point in its external housing for steerable or single bend motors. Bent-housing angles range from 0 to 3° in most cases and may be either fixed or rig-adjustable.



Bearing Assembly

The "TL-Drill" bearing assemblies are a mud-lubricated design that utilizes two types of bearings: thrust and radial. The bearing assembly supports the "TL-Drill" motor drive shaft, which in turn transmits drilling thrust and rotational power to the drill bit. Drilling parameters, such as weight on bit (WOB), circulation rate, and bit pressure drop, directly affects the bearing assembly.



Seal Free Bearing Assembly (Journal Bearing)

"TL-Drill" uses a stacked multiple ball-and-race design for the thrust bearings. The thrust bearings support the downward force resulting from the WOB and the loads from the combination of hydraulic thrust and weight loads from internal components.

Radial bearings support the radial loads on the drive shaft and regulate the flow of drilling fluid through the bearing assembly. Diverted fluid cools and lubricates the radial and thrust bearings. "TL-Drill" uses radial bearings with tungsten carbide tiles imbedded in a tungsten carbide chip matrix for maximum performance and superior resistance to radial wear.

The "TL-Drill" bearing section is an open bearing design (i.e. the bearings are lubricated by the drilling fluid). An open bearing system offers the advantage of allowing higher differential pressures across the drill bit without the concern of losing seal integrity which is possible with sealed bearing system.

Oil Sealed Bearing Assembly

The bearings are not subjected to drilling fluid and should provide extended, reliable operation with minimal wear. As no drilling fluid is used to lubricate the drilling motor bearings, all fluid can be directed to the bit for maximized hydraulic efficiency. This provides for improved bottom-hole cleaning, resulting in increased penetration rates and longer bit life.

PDC Bearing Assembly

Incorporates PDC thrust bearings directly replace roller or ball bearings and microwave sintered carbide (MSC) radial bearings.

The Use of PDC thrust bearings results in lower reactive torque than roller or ball bearings, which reduces power loss in the tools. PDC bearings are able to carry much higher loads and can operate in harsh downhole environments without protection.

Because PDC bearings can operate in mud, air, or air mist environments without seals, they can be used in high temperature applications up to 1600°F.

Typical life improvement of PDC thrust bearings versus standard roller or ball bearings is usually 10 to 20 times or longer.
Radial bearings utilizing MSC inserts have demonstrated up to 10 times life improvement over conventional carbide bearings

DRILLINGMOTOR OPERATION

Motor Selection

While the proposed drilling operation maybe very complex and require detailed planning, a number of factors must also be considered when selecting the motor. The particular application for which the motor will be used is the first consideration.

Applications

- Directional drilling
- Steerable-system drilling
- Horizontal drilling
- Directional crossing
- Performance straight-hole drilling
- Casing drilling
- Air drilling
- Coring
- Reaming / hole opening / under-reaming
- Prevention of casing wear

Other Factors for Motor Selection

- Bit type
- Speed
- Torque
- Weight-on-bit (WOB)
- Bit pressure drop
- Flow rate / annular velocity required to clean the hole
- Mud type (composition)
- Bottom hole circulating temperature
- Hole size
- Tubular specifications
- Stabilizer placement
- Well profile
- Site logistics

Operational Procedures

Proper and efficient operation of the motor depends on many different procedures being carried out according to TL-DRILL specifications. The following procedures are guidelines that should be observed on the rig.

Caution: Safety glasses, steel-toed shoes and a hard hat are to be worn and all applicable rig floor safety procedures are to be followed while performing any of the following procedures. Lifting and torque equipment should be checked for ratings and operational condition per appropriate specifications.

Making up the Motor

1. Using a bit breaker, make up the drill bit by placing tongs on the motor bit box.

   Caution: If a bit crossover sub or thread adapter is used, the overall length of the sub should be only long enough to accept make-up tongs (recommended maximum is 10 inches or 25.4cm.) .Lengths greater than those recommended may reduce bearing life, affect directional characteristics of the tool, or result in driveshaft breakage and loss of the bit and sub in the hole.

2. After the bit is made up, one of the following steps should be taken to break "dry contact" between the rotor and stator and increase stator life:

   - Place make-up tongs on the stator and, with the bit in the bit breaker, slowly rotate the rotary table one to two revolutions in the counter-clockwise direction. -or-

   - Place make-up tongs on the stator, lock the rotary table and pull on the tongs to rotate the stator one to two revolutions in the clockwise direction.

3. Lower the tool into the slips and secure with a drill collar clamp before removing or making up additional equipment.

4. If required, a float sub can be installed immediately above the tool. A float sub will avoid problems with plugging of the bit and motor while tripping in the hole. A float valve is generally used for milling steel, drilling underbalanced, or when drilling in very unconsolidated formations.

   - Avoid screwing into the threads above the motor by rotating the rotary table counter-clockwise. The bit could hang up on the casing wall and result in unscrewing the tool's internal threaded members or cause the bit to unscrew and be lost in the hole.

   - To avoid unscrewing internal joints, the bit box should be turned only counter-clockwise with respect to the motor housing above.

Dump Valve Test (if equipped)

It is recommended that a dump valve test be performed on the motors supplied with a dump valve.

1. Apply pressure to the tapered face of the piston with a probe (e.g., a hammer handle). Piston travel should be about 3 inches with moderate pressure applied.

2. Fill the valve body with water and then release the piston. Water should flow freely from all ports.

   Note: A dump valve malfunction caused by abrasive drilled solids may be remedied at the rig site by:
   - Blanking-off the ports before running in hole. –or-
   - Replacing the dump valve sub with a crossover sub.

Adjustable Bend Housing Operation

The procedure is simple; however, the following guide lines should be followed when setting the

ABH:

- Tong on the upper and lower ABH housing only. Do not tong on the adjusting ring.
- Rotate the adjusting ring no more than ½ turn when setting the angle.
- Align the desired angle mark of the adjusting ring to the angle mark on the housing.
- Be sure that the adjusting ring alignment slots are fully engaged prior to torque the connection.
- Do not use thread-locking compound on the threads of the ABH.

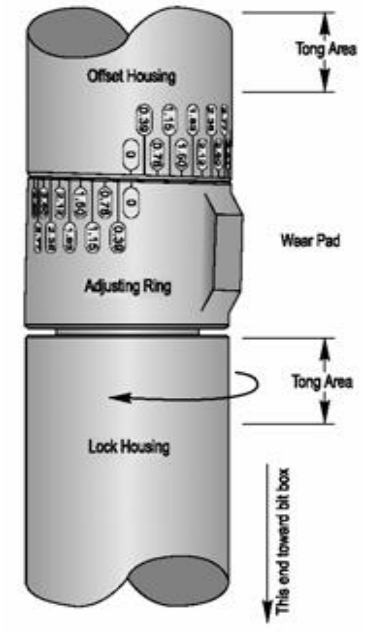
The "TL-Drill" adjustable bend housing allows for quick and easy bend angle adjustment from 0 to 3°. Below is the procedure for setting the "TL-Drill" adjustable bend housing.

Refer to Figure 1 for steps 1 and 2:

1. Place the jaws of the tongs in the tong area shown and break the tool joint.
2. While keeping the adjustable ring teeth engaged with the mated slots in the offset housing, unscrew the lock housing two to four complete turns in the clockwise direction (unthread).

Refer to Figure 2 for steps 3 and 4:

3. Slide the adjusting ring down to disengage the teeth in the ring and the offset housing.
4. To adjust the bend angle of the bent housing, rotate the adjusting ring clockwise until the desired bend-angle marking matches the bend angle marking on the offset housing.



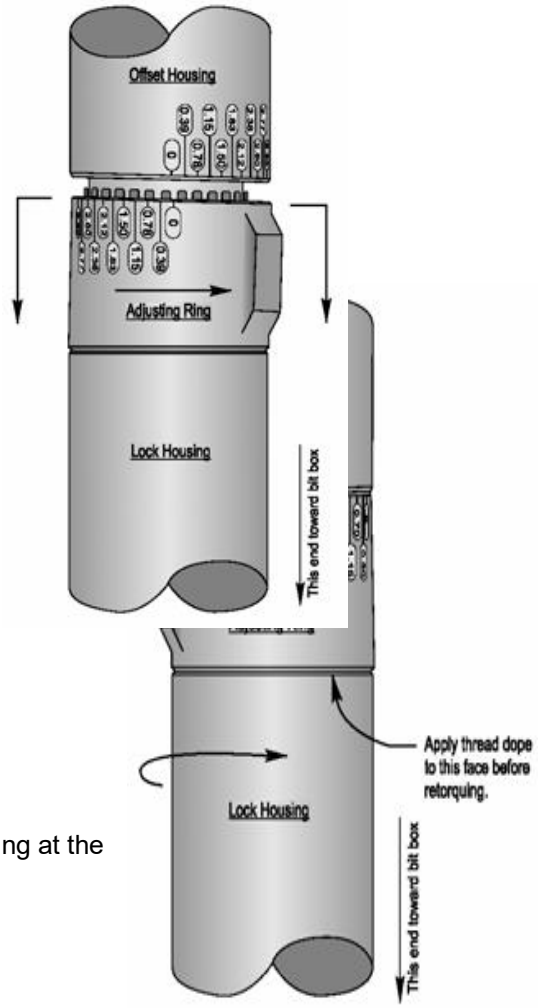


Figure 1

Refer to Figure 3 for steps 5 through 7:

5. Engage the teeth of the adjusting ring and the offset housing at the

desired bend angle.

6. Apply thread dope to the mated faces of the lock housing and the adjusting ring.
7. Screw the lock housing and the adjusting ring together and apply the torque value listed in the following table. The matching markings on the OD of the offset housing and the adjusting ring indicate the bend angle selected as well as the high side marks to identify the high side of the tool.

Figure 3

LOCK HOUSING MAKE-UP TORQUE		
Motor size	**English**	**Metric**
2-7/8 (287)	2,200 ft-lbs	3,000 N-m
3-1/8(313)	2,700ft-lbs	3,600N-m
3-1/2(350)	3,800ft-lbs	5,100N-m
3-3/4(375)	4,600ft-lbs	6,300N-m
4-3/4(475)	9,500ft-lbs	12,700N-m
5-1/2 (550)	16,000 ft-lbs	21,700 N-m
6-1/2(650)	23,000ft-lbs	31,000N-m
6-3/4(675)	27,000ft-lbs	37,000N-m
7-3/4(775)	29,000ft-lbs	39,000N-m
8 (800)	30,000 ft-lbs	40,300 N-m
8-1/2(850)	38,000ft-lbs	51,000N-m
9-5/8(963)	61,000ft-lbs	83,000N-m
11-1/4” (1125)	100,000 ft-lbs	136,000 N-m

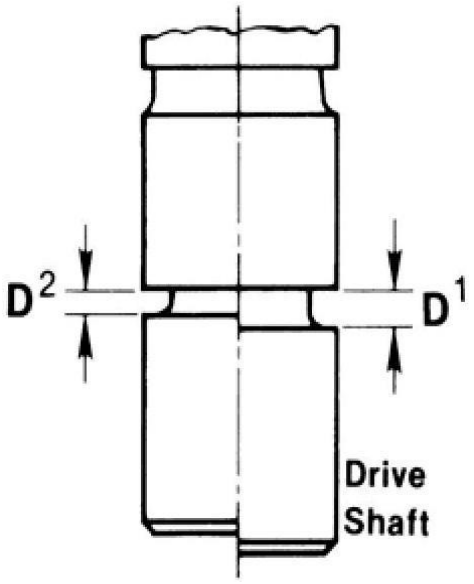
Determine Thrust Bearing Life

1. Check thrust bearing wear prior to using the motor to determine remaining bearing life. Thrust bearing stack wear can be determined by the amount of play the drive shaft has between the back face of the bit box and the outer face of the stationary bearing.

2. Lift the motor off the rig floor and let it hang free. Take a measurement (D1) between the bearing housing nut and the drive shaft bit. Lower the motor until it sits flat on the rig floor and then take a measurement (D2) at the same location.

3. Subtract D2 from D1 and this will determine thrust bearing stack wear.

4. Do not use the motor if the thrust bearing stack wear exceeds the amount listed in the table below.



Tool size O.D.	(D1 – D2) mm	(D1 – D2) in
2-7/8	3	1/8
3-1/8	3	1/8
3-1/2	3	1/8
3-3/4	3	1/8
4-3/4	3	1/8
5-1/2	5	3/16
6-1/2	5	3/16
6-3/4	5	3/16
7-3/4	6	1/4
8	6	1/4
8-1/2	6	1/4
9-5/8	7	9/32
11-1/4	9.5	3/8

Surface Flow Test

Caution: A surface flow test is not recommended when using PDC/diamond bits in the casing.

1. Make up the Kelly to the TL-DRILL motor and lower the dump valve ports below the rotary table.
2. Start the rig pumps, using only enough pump strokes to close the dump valve and operate the motor. Use minimum flow rate for the first few revolutions, then increase slowly as needed.
3. Raise the tool far enough to visually check that the bit sub is rotating and the tool is operational.
4. If equipped with a dump valve, then lower the dump valve ports below the rotary table. Stop the pumps. Keep the dump valve ports positioned below the rotary table until the dump valve opens and external drainage stops.
5. Keep the test short to avoid damage to the bit, surface pipe, or blowout preventer (BOP) stack.

Tripping Recommendations

Tripping In the Hole

While "TL-Drill" drilling motor is a reliable tool, it is susceptible to damage if care is not taken when tripping the drill pipe. The following are recommendations for tripping in the hole.

- Trip in at a controlled rate to avoid damage from striking bridges, shelves, or casing shoes.
- Ream through any tight spots by starting the pumps and reaming slowly. Excessive reaming operation may shorten motor life.
- Caution: To avoid sidetracking when tight spots are encountered in a directionally

controlled wellbore, the pumps should not be started without a directional driller or other knowledgeable and responsible person on the rig floor.

- If tripping to extreme depths and/or temperatures, periodic stops for circulation (staging in the hole) are required. Every 20 to 40 minutes, it is recommended that the drill string be circulated for one-half to one minute with the lowest volume and pressure necessary to start the motor.
- If extended circulation is required while in the casing, reciprocate the Kelly to avoid localized casing wear.
- If there is a float valve in the string or if fluid characteristics prevent easy flow, periodic stops are recommended to fill the drill pipe.
- Caution: Reduce tripping speed when approaching the last 60 to 90 feet of hole. There may be fill in the bottom of the hole or the pipe tally may be incorrect.

Tripping Out of the Hole

The following are recommendations for tripping out of the hole

- The dump valve opens when the pumps stop, allowing the drill pipe to drain while tripping out of the hole. However, if there is internal pressure in the drill string, the dump valve will shut and a wet trip will occur.
- When tripping out, the rotary table should not be used to break out connections of double-bend assemblies or steerable assemblies inhigh build-rate intervals.
- Slow down when nearing casing shoe points.
- Control tripping speed to avoid swabbing the hole.
- Avoid excessive back-reaming. It shortens motor life.

Maintenance Procedures after Tripping

The following post-run maintenance steps are required after tripping out of the hole:

1. Remove remaining fluid from the motor by placing the bit in a bit breaker.
2. Secure the motor body above the rotating bit sub with rig tongs.
3. Rotate the rotary table and bit counter-clockwise, forcing or “pumping” the fluid out the top of the motor.
4. After the bit has been removed, spray water directly through the bit box. This will wash out the ports above the drive shaft and help clean the bearing section.
5. If the tool is equipped with a dump valve, pour clean fluid into the top of the dump valve. Work the piston until it travels freely between the down (closed) and up (open) positions.
6. If the tool is to be stored for an extended time before re-use, pour a small amount of mineral oil or equivalent into the motor. Do not use diesel oil.
7. Re-dope the bit box and dump valve box. Install thread protectors.

Drilling Considerations

The performance life of the motor is determined by the environment in which it operates. To ensure optimum performance, avoid:

- Abrasive solids in the circulating system.
- High temperatures.
- Exceeding the recommended pressure drop across the bit and motor
- Pumping higher than recommended fluid volume.
- Exceeding recommended bit weight loading resulting in excessive pressure drop across the tool.

Drilling Fluid Requirements

Except for special applications, the recommended minimum/maximum flow rate for each motor should be observed to achieve optimum torque and tool life. Flow rates for each "TL-Drill" drilling motor are given in this Motor Operations Manual.

Optimum Operating Performance

Operating performance charts are included in this manual and provide the following:

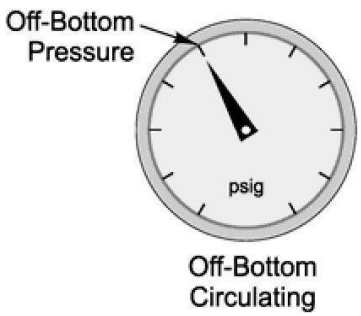
- Bit weight
- Bit pressure drop
- Bearing loads
- Operating torque
- Revolutions-per-minute (rpm) range
- Motor differential pressure

Starting the Motor

Before touching bottom of the hole, start the pumps and increase the flow rate slowly to the recommended operating range.

Drilling

The "TL-Drill" motor is a hydraulically operating tool. Therefore, the primary rig-floor reference is the standpipe pressure gauge. The weight indicator may, for example, give inaccurate information about actual WOB because of “Wall Hanging” while sliding. In this case, the only true indication of whether the bit is on bottom drilling, is the pressure gauge. Refer to the following figures for examples of off-bottom, drill-off, and stall-out conditions.



Off-Bottom Pressure

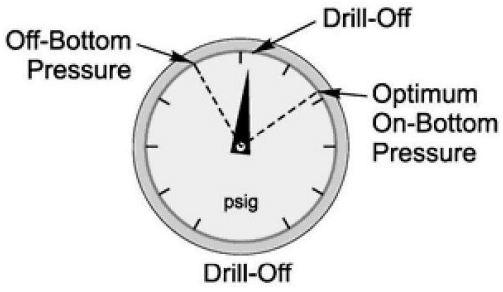
When the motor is off-bottom circulating, the standpipe pressure gauge shows the total amount of pressure required to pump a

known volume of fluid through the drilling system. This is called “off-bottom” pressure.

Available torque is directly proportional to the pressure drop across the motor and is indicated as a change in total system pressure. Motor differential pressure is defined as the pressure above off-bottom pressure.

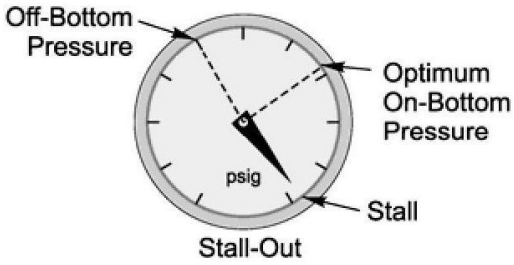
Note: when the bit is side loaded from the bent housing or bent sub, off-bottom pressure includes motor pressure to provide torque to rotate the bit with imposed side load. The motor differential pressure is obtained from standpipe pressure only when the bit is not side-loaded or when system pressure losses without the motor are known.

Pressure While Drilling



More WOB means a higher total system pressure at the surface. As the bit drills off, the total system pressure decreases. The standpipe pressure gauge, therefore, can be used as an indicator of bit weight and torque. Drill pipe friction will not distort the readings. When the pressure gauge reads the optimum on-bottom pressure and the driller subsequently stops adding weight to the bit, a drill-off occurs. The pressure will steadily fall until the driller puts more weight on the bit. Performance curves and recommended motor differential pressures are included in this manual.

Stall Pressure



If the driller overloads the bit, a stall will occur. The backpressure in the drilling fluid will deform the rubber in the stator and flow straight through without turning the rotor. The pressure gauge will rise abruptly, and then remain stationary, even if more weight is added to the bit.

When a stall occurs, the driller merely has to raise the bit off bottom slightly to restart the tool and continue drilling. Stall pressure is about twice the recommended optimum differential pressure across the motor.

Caution: Operating for an extended period of time in a stalled condition will cause damage to the rotor and/or stator.

Rotating the Motor

Steerable applications and many straight-hole applications require rotation of the drill string and motor for directional control, reduced drill string torque/ drag, cuttings transport, and differential sticking. It is recommended that drill string rpm be minimized to prolong motor life. A maximum drill string speed of 60 RPM is recommended, although 120 RPM may be permissible in some areas.

The two most common problems associated with drill string rotation are component fatigue and connection back off. Fatigue is a function of stress level and the number of cycles at that level. Increasing RPM increases the number of stress cycles within a given period of time, thereby potentially reducing component life.

Connection back off may occur when the drill string momentarily stalls, then breaks free and momentarily accelerates. Back off normally occurs when drilling through ledges, tight spots, or formation stringers. This condition, also known as “stick-slip” causes severe lateral vibration, which may result in connection back off. When drilling through stringers or other formation conditions

known to cause drill string stalling or stick-slip, reduce rotary speed as much as possible. Reducing rotary speed reduces the energy available to cause problems.

Caution: When a drill string is completely stalled, do not pick up the drill string until the torsion energy in the drill string is released. Allow the drill string to slowly drive the rotary table or top drive backwards until all of the torque is released. Then pick up the drill string and resume drilling at reduced RPM until the stick-slip condition is overcome.

An additional factor in rotating the drill string is the angle of the bent housing in steerable applications. Typically, the bent-housing angle should be restricted to 1½ degrees or less for drill string rotation to prolong motor life.

Factors that Affect Build Rate

Many factors affect build rate such as tool-size to hole-size ratio, drilling fluid type, flow rate, hole erosion, formation anisotropy, placement of stabilizers or pads, bottom hole assembly (BHA), motor bend angle and distance from bit to bend, and the type of bit used. Following these recommendations can minimize these factors affecting build rate:

- The lower the tool-size to hole-size ratio, the better the building capabilities.
- The placement of pads and the use of stabilizers on the OD of the bottom hole assembly can play a critical role in achieving good build rates.
- Build rate can be better predicted if formation-class empirical data are available. Some formations prohibit good build rate, and these types of formations should be identified while planning the drilling program.
- Build rate is related to bend angle severity and distance from the bend to the bit.

Power Section Performance Factors

Although TL-DRILL positive-displacement motors are designed to operate in a wide variety of downhole drilling environments, several factors that affect power section performance and operating life must be considered. These factors include:

- Drilling Mud
- Air, foam, or mist
- Fluid pressure limitations (stalled motor)
- Excessive flow rates
- Temperature.

Drilling Mud

While TL-DRILL motors are suitable for wide range of drilling mud, the following factors should be considered.

Mud Solids

Drilling-fluid properties should be maintained within the same constraints as when rotary drilling. However, the following special precautions should also be observed:

- The mud should be free of plugging agents, as well as foreign bodies.
- The use of a drill pipe screen is recommended.

- The fluid should have the least possible sand content (1% or less is recommended).
- Drilling fluid additives should be used only in limited amounts. Excessive amounts of drilling fluid additives, such as lost circulation material (LCM), can affect tool performance. Drilled solids and/or abrasive additives should be kept to a minimum. A poorly mixed slug of weighted material or LCM can cause nearly instantaneous termination of an otherwise good motor run.
- Where possible, hematite-weighting materials should not be used. These materials have been shown to greatly reduce motor life.

Oil-Based Mud

Oil-based mud and mud that contain oil can reduce stator life. The degree of stator damage depends on the specific chemistry of the oils used. One measure of oil's aggressiveness in damaging elastomers is the oil's aniline point. The aniline point of a material may be defined as the lowest temperature at which equal volumes of freshly distilled aniline and the oil being tested are completely miscible. As oil's aniline point decreases, the oil becomes more damaging. While aniline point is a useful measure, some oil-based mud is still aggressive despite a high aniline point.

Note: Tests for mud-elastomer compatibility with TL-DRILL elastomers may be conducted when fluids are anticipated. Stators must contain compatible rubber compounds for oil-based mud. Because of the severe degradation of elastomers exposed to drilling fluids at temperatures above 300°F, "TL-Drill" strongly recommends that elastomer compound selection for bottom hole circulating temperatures (BHCT) over 300°F be based on fluid compatibility testing.

Mud Additives

Certain amine-based additives, such as emulsifiers, corrosion inhibitors, and scavengers, can (even in very small quantities) cause elastomer failure.

Brine or Fresh-Water Mud

Brine and fresh-water mud (but not bentonite gels) provide little lubrication for motor stator elastomers, so abrasive wear between rotor and stator can be a concern. Additionally, the adhesives used to bond elastomers tometals can undergo hydrolysis when exposed to water, especially at temperatures in excess of 200°F. Bond-strength degradation can trigger a multitude of problems, some minor and some causing catastrophic failure of the downhole motor. Brine drilling fluids may also cause corrosion of rotors,dump valves, or other components. Special coatings are available.

Air, Foam, or Mist

The use of air, foam, or mist may adversely affect motor performance unless guidelines are followed concerning motor lubrication, air-volume requirements, and WOB.

Fluid Pressure Limitations / Stalled Motor

When enough WOB is added to exceed maximum design pressure, the motor will stall. When mud pressure, as indicated on the mud-pressure gauge, increases, stall is indicated and does not vary as additional weight is added to the bit.

Bored Rotors / Extended Flow Rates

To extend the allowable flow-rate range of multi-lobed power sections, bored rotors with selectable nozzles are available. To avoid adverse effects on motor performance, care must be exercised in nozzle selection. Contact your TL-DRILL representative for recommendations on optimum flow

rates and motor performance.

Temperature Effects

The effects of temperature can have a drastic effect on the life of the stator. A high bottom-hole temperature can affect the interference fit between the rotor and stator. This can result in stator damage or reduced operating life In general, as temperature increases, motor life decreases. Standard TL-DRILL stator elastomers are rated to 250°F (120°C). A motor operated, even for a limited time, at temperatures at or above the designed operating temperature will shorten the expected motor life.

Special Applications

Air, Foam, or Mist Drilling

The TL-DRILL motor can be used successfully for directional drilling purposes where air and air/mist is the circulating media.

Air-Volume-Requirement Guideline

To convert liquid-volume requirements to air-volume requirements, use the following conversion: 1 gallon per minute (gal/min) of drilling fluid equals 4 to4 ½ standard cubic feet per minute (scfm) of air.

Example: 400 gal/min = 1,600 to 1,800 cfm

Foam-Volume-Requirement Guideline

It is recommended that 3 1/2 to 4 1/2 scfm of air plus 10 to 100 gal/min of injected foam be used.

Pressure Requirements

The pressure required with air, foam, or mist drilling is approximately twice the pressure required when liquid drilling fluids are used.

Dump Valves

Dump valves should not be used. If the motor is equipped with a dump valve, replace it with a crossover sub. If a crossover sub is not available, then remove the dump valve internal assemblies and blank off the outlet ports.

Flapper Valve

A flapper valve should be used to control bleed-off and when running wireline tools. Float valves should be placed immediately above the motor and on the surface to avoid blowback on connections. String float valves can be run every 1,000 ft for additional control.

Air Operation Factors

When operated on air, the tool will:

- Be more weight sensitive than in fluid
- Stall out at lower pressure
- Require less WOB to drill

Lubricants – General Recommendations

Using dry air causes high rotor/stator friction and can result in short runs. It is recommended that a minimal amount of lubricant (consistent with formation capability, available equipment, etc.) be run. The most successful lubricants used have been:

- Liquid soap — 0.5 to 1 gal/bbl of water
- Graphite — 4 to 6 lb/bbl of water
- Gel — 0.5 to 1 lb/bbl of water
- Oil — 0.1 to 0.6 gal/hr

Lubricants should be injected in fresh water downstream of the air compressors.

Bit Selection

Best results have been obtained with sealed bearing bits. To reduce pressure requirements on the air compressor, jets should not be used in the bit.

Operational Cautions

Start the motor by applying a light weight on the bit and pumping air. Do not allow the tool to run freely off-bottom. If the bit is allowed to run freely off bottom, then bit speed will increase rapidly as air expands through the motor, and potential damage may result. Such damage may include:

- Stator damage due to friction/heat
- Bearing damage if weight is applied suddenly to the bit

Before picking up off-bottom, turn off the air compressor and allow the air pressure to bleed off until standpipe pressure is equal to annulus pressure.

Coring

Several coring operations with PDMs have demonstrated the cost effectiveness of using a downhole motor in this difficult application. Slow speed motors are especially suited for coring because of their high torque at moderate speed. Slow-speed, high-torque motors can drive core barrels upto 90 ft in length.

A drop-ball sub is typically run between the motor and core barrel. An increase in flow rate causes a steel ball to drop from this special sub, thereby redirecting fluid flow to the annulus between the inner tube and outer tube of the core barrel for the coring operation. In general, the material used in a core bit should be one grade softer than the material used in a normal rotary bit.

High-Temperature Environments

PDMs are designed with an interference fit between the rotor and stator, establishing a seal. For the motor to operate efficiently, the interference fit must remain within a specified range. A high bottom-hole temperature can increase the interference fit, which can result in stator damage or reduced operating life. As temperature increases, motor life decreases. Although a motor may be operated for a limited time at temperatures above the designed operating temperature, shortened life can be expected. Motors are designed for specific temperature ranges, either below approximately 250°F (120°C) or above approximately 300°F (150°C). For optimum performance, the motor should be selected according to the temperature range in which it is expected to operate.

Hot Hole Procedure

For a bottom hole circulating temperature (BHCT) exceeding 250°F (120°C), the following guidelines apply:

- Stage in the hole:
  - When reaching the depth where temperature is estimated to be approximately 250°F (120°C) ,stop and circulate cool fluid to the motor.
  - Continue pumping for a few minutes (at low volume) to reduce equipment temperature.
  - Continue this process in stages of 500 to 1,000 ft until reaching operating depth.
- Non circulating periods (Survey, Orientation, etc.) must be as short and as infrequent as possible.

Casing Drill

Simultaneous drilling and running large-diameter surface casing has saved many hours of rig time in both land and offshore operations. This operation is performed with a casing drill, which is an assembly consisting of: a bit, a "TL-Drill" motor, a jet sub, drill collars, and crossover subs. All of these items are suspended by a running tool that is latched into a preassembled conductor pipe. When the desired depth is reached, the drilling assembly is unlatched and tripped, leaving the conductor pipe in place.

The casing-drill tool and technique are typically used in unconsolidated alluvial formations, such as those found in the Gulf of Mexico. The operator can benefit from running surface casing while drilling, and the risk of losing the hole from sloughing when retrieving the drilling assembly is eliminated.

A typical offshore casing-drill operation is performed as follows:

1. Determine the customer's drilling specifications, such as angle, rotation, soak time, and sweeps.
2. Determine the available volume of drilling fluid, then size the nozzles in the bit and jet sub accordingly.
3. Measure the length of the casing assembly (wellhead, casing, and shoe joints).
4. Measure the internal BHA, including the lower portion of the running tool that is dependent on the length of the casing assembly. Determine how the BHA will be spaced inside the casing assembly. Preassembly of the BHA is recommended to minimize BHA exposure to the elements of the offshore environment.
5. Position the guide base and/or the mud mat in the moon pool of the drilling vessel.
6. Assemble the casing (with welded or mechanical connections). Lower into the moon pool.
7. Assemble the BHA and lower it into the casing. Make up the running tool on the wellhead joint.
8. Lower the BHA to the mud line while keeping a pipe tally to verify water depth.
9. Perform preliminary checks of the bulls eye reading, rotation of the casing string, and condition of the running tool.
10. Tag the mudline and begin drilling.
11. Monitor mud-pump volume, mud-pump pressure, WOB, and ROP. Work or reciprocate the string as required.
12. Monitor the well deviation, and control drill to the desired depth.
13. After reaching the predetermined depth, visually confirm the angle and depth readings. If a remotely operated vehicle (ROV) is available, confirm the rotation. Soak for the specified period, release the running tool, and pull out of the hole.

It is recommended that a trained, experienced motor operator be onsite to supervise the operation of a casing drill.

Remedial and Production Applications

Production, remedial, and special drilling problems can be solved with a TL-DRILL mud motor. The motor can be used for:

- Drilling through sand bridges and cement plugs
- Removal of paraffin buildup
- Minerals exploration
- Pilot-hole drilling
- Horizontal boring

Short-Radius Applications

TL-DRILL offers small OD drilling motors such as the 2-7/8", 3-1/8". 3-1/2" and 3-3/4" tool which can be used in short-radius applications. Short radius drilling is a high specialized application for drilling motors, and each well requires thorough drill string and BHA analysis.

Coiled-Tubing Applications

TL-DRILL motors can be used in many types of coiled tubing (CT) applications. Remedial, production, and drilling jobs have been successfully executed, primarily with 3-1/2" OD and smaller motors. The following are important items to consider when planning a motor run on coiled tubing:

Pressure Drop through the Coil

Unlike conventional drilling operations, the length of CT, spooled or unspooled, is fixed at all times. Hydraulic calculations must be made to ensure that the recommended flow-rate range of the desired motor can be achieved within the maximum working pressure of the pumps and the CT.

Coil Torsional Yield

The maximum stall torque of the motor should not exceed 80% of the nominal torsional yield of

the tubing for vertical drilling, and 50% of the nominal yield for drilling directional wells. The lower figure for directional applications allows greater coil stiffness for a more stable tool face. All other applications should adhere to the 80% rule. Mechanical properties of popular sizes and types of CT can be found in manufacturers' handbooks.

Coil Buckling

Computer software is generally available to calculate maximum WOB available for a given directional or horizontal-well profile. For vertical applications, it is recommended that drill collars be run with sufficient outside diameter (OD) and length to keep the CT in tension while providing sufficient WOB.

Depth Control

When CT is used, depth control becomes critical in deeper wells (greater than 5,000 ft). It is recommended that at least two depth-tracking methods be available. Commonly, mechanical and electronic devices are used simultaneously, and their outputs are compared for accuracy during the job. In the absence of backup systems, the CT can be hand strapped during tripping.

Trouble Shooting

TL-DRILL downhole motors are designed and manufactured with strict adherence to high quality control standards. Generally, if proper operational procedures are followed, "TL-Drill" drilling motors provide trouble-free performance. However, should a problem arise, refer to the Troubleshooting

Chart on the following page. It describes commonly encountered drilling problems and provides possible solutions for each.

Note: The troubleshooting chart offers assistance in solving common motor situations that may develop; however, it is not intended as a substitute for experienced supervision.

Motor Blockage
If there is no float valve in the string and "backflow" is observed while making up connections, it is possible that sand and other debris may have entered the drill string. This condition may result in complete blockage of the motor, requiring a trip to change out the motor

Motor Trouble Shooting Chart

A problem has occurred when any condition other than "normal" is indicated in the columns below						Possible Cause	Remedial Action
Flow Rate	Off-Bottom Pressure	On-Bottom Pressure	Indicated WOB	Rotary Torque	ROP		
Normal	Normal	Higher	Normal	Higher	None	Motor Stalled	Pick up drill string
					Lower	Roller Cone bit bearings locking	Trip out for bit
		Lower	Normal	Lower	Lower	Bit cutter wear	Evaluate economics; Trip out for bit
						Drill string hanging up reactive torque lower (orientated mode)	Work drill string
				Higher	Lower	Drill string hanging up	Work drill string; Ream (rotary mode)
	Lower	Lower	Normal	Normal	Normal	Lost circulation	Lost circulation procedure
					Lower	Surface equipment washout	Check surface equipment
						Drill string washout	Tripe out looking for washout
						Dump valve open	Stop pumps– reciprocate drill string- restart pumps
				Lower	Higher	Gas kick	Well control procedure
	Higher	Higher	Normal	Normal	Normal	Bit partially plugged	Stop pumps– reciprocate drill string- restart pumps
						Drill pipe screen partially plugged	Check & clean screen
					None	valve closed	Check surface system
						Motor/bit plugged	Trip out
				Higher	Lower	Bit side loaded	Work drill string (orientated Mode) Ream (rotary mode)

Motor Specifications

TL-DRILL offers multiple configurations for each size of drilling motor. This section provides

complete technical specifications, performance curves, and builds rate prediction tables for each motor.

The TL-DRILL model number provides an easy method of determining the motor configuration. The TL-DRILL model number description is given below:

Model Number Description

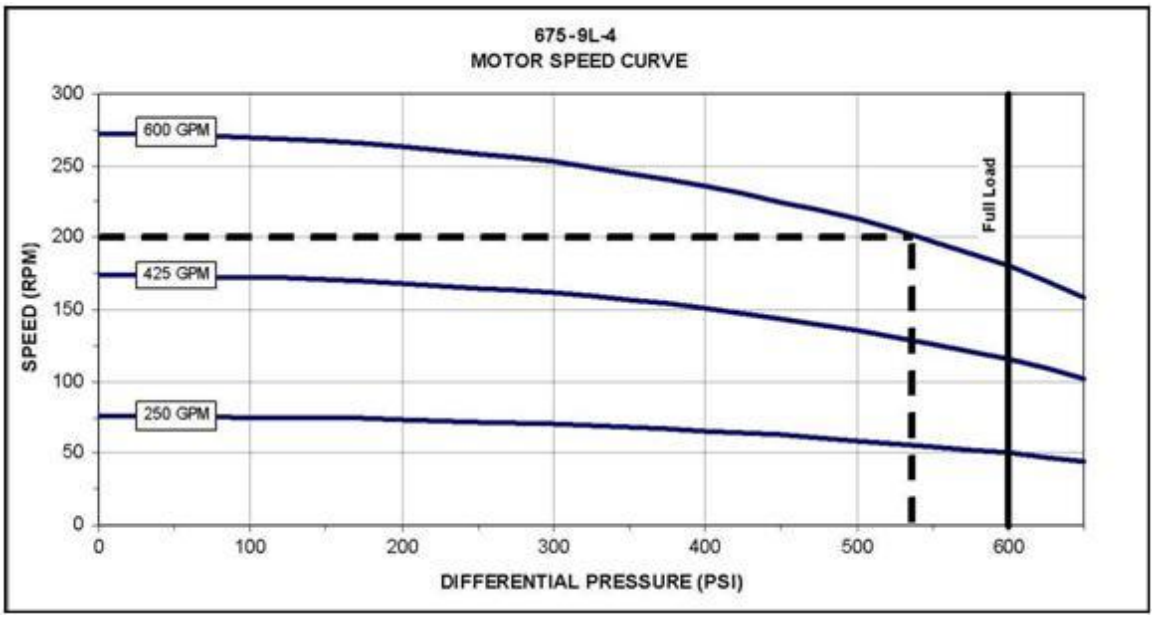
675 – 9L – 4

- 4 — Number of Stages
- 9L — Number of Lobes
- 675 — Tool Outer Diameter (6-3/4")

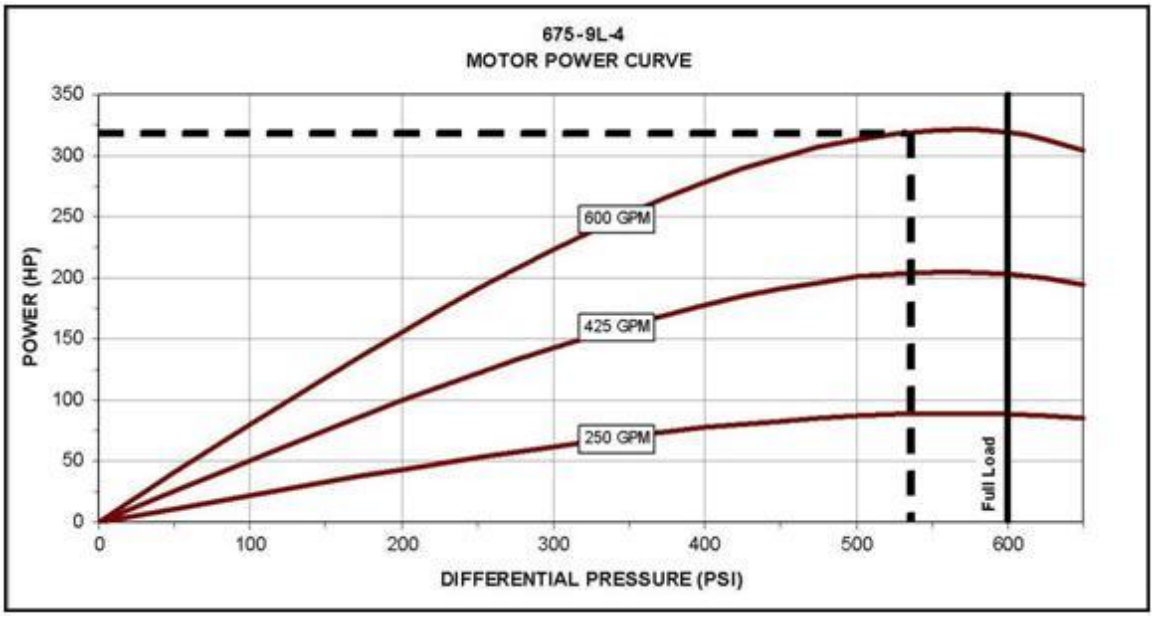
Motor Performance Curves

Motor performance curves are given for each motor size. A speed curve, power curve, and torque curve are provided. The performance curves are provided as a function of the differential pressure across the drilling motor. The full load condition is also indicated on the plotted curves.

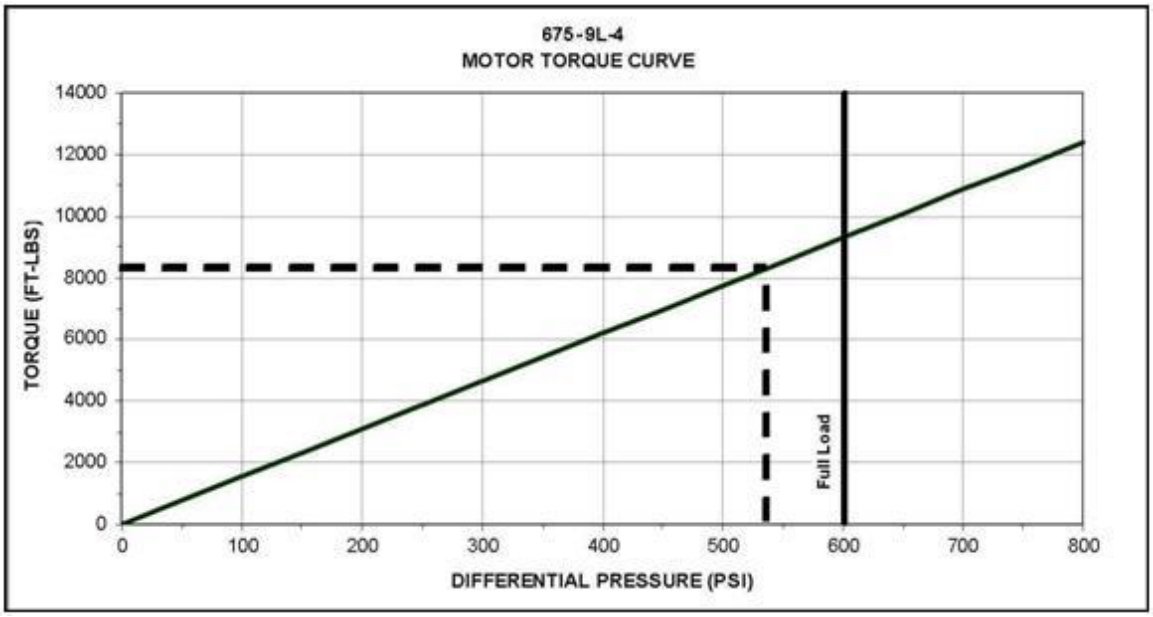
Examples of how to read the motor curves are given below:



The 9L-675-4 motor operating at a flow rate of 600 GPM, will have a rotational speed of 200 RPM at approximately 530 PSI differential pressure and …….



….. The 9L-657-4 motor operating at 600 GPM, will have an output power of approximately 320 HP at the same 530 PSI differential pressure and …….



….. The 9L-657-4 motor operating at 600 GPM, will have a torque output of approximately 8,500

Ft-Lbs at the same 530 PSI differential pressure.

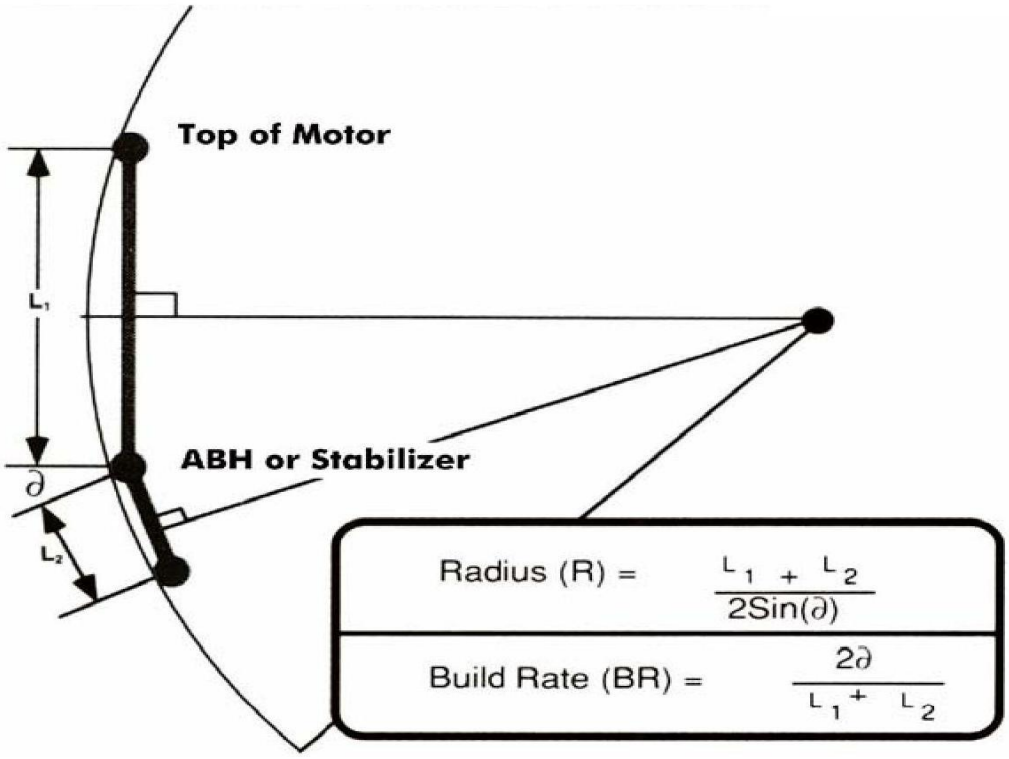
Build Rate Prediction Tables

The follow are some notes regarding the build rate prediction tables given in the motor specification sheets

- The build rate prediction values will vary as the gauge and placement of the motor stabilizers, sleeves, or pads are changed.
- While the motor is sliding, it is assumed that an in-gauge hole is drilled.
- A short-gauge bit will produce better directional tendencies than an extended-gauge bit.
- The formation is assumed to be homogeneous.
- The tables assume all stabilizers are 1/8" (3.2 mm) Under gauge.
- The build rate prediction values should be regarded as estimates and should only be used for general guidance. Formation characteristics, bit profile, BHA design, and drilling parameters can all affect the directional response.
- The units for Build Rate Prediction are in degrees per 100 ft.

All TL-DRILL drilling motors are engineered as "three-point" curve drilling assemblies. Since any three points not in a line describe an arc, the drill bit, the top of the motor, and the lower stabilizers (if any) create such an arc.

The



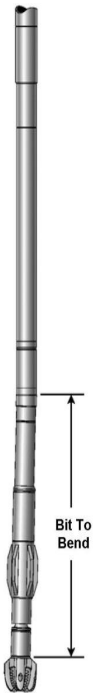
Following are the motor specifications and performance data for the TL-DRILL drilling motors.TL-DRILL has taken every precaution as to the accuracy of the content and data presented in this section. TL-DRILL make no warranties, guarantees, or representations concerning the accuracy or individual interpretation of the data. It is recommended that the nearest TL-DRILL representative be contacted for the latest information.

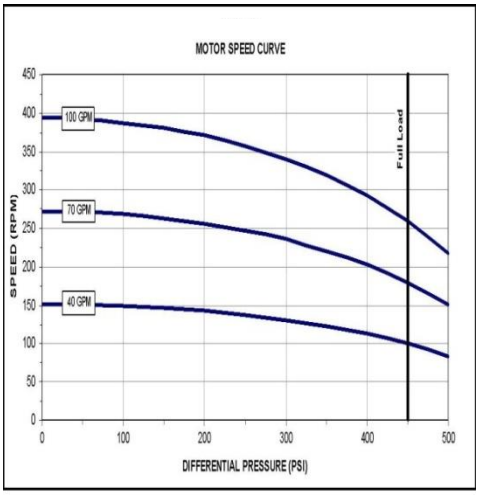
TL-Drilling Motors (2-7/8")

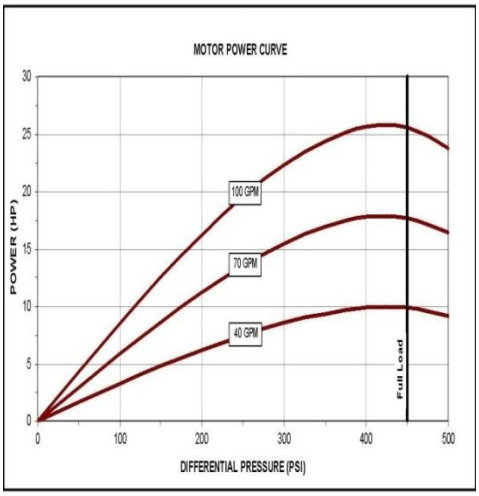
TL-DRILL – 288-5L-3

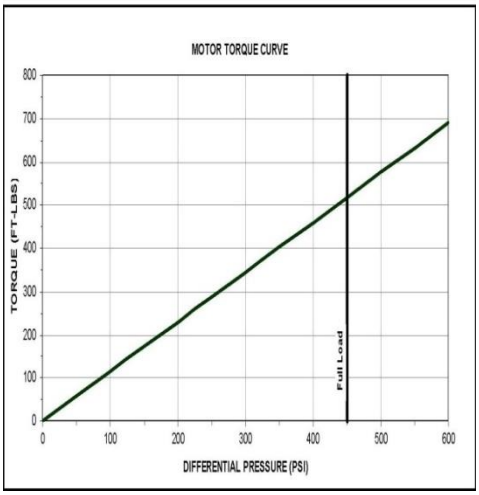
Motor Specifications

Tool OD	2-7/8"	73 mm
Number of Lobes	5:6	
Number of Stages	3	
Weight	140 lbs	63 kg
Length	10.1 ft	3.10 m
Flow Rate	40-100 gpm	151-379 lpm
Bit speed at Full Load	100-260 rpm	
Maximum Torque	690 ft-lbs	936 N-m
Maximum Power	34 hp	25 Kw
Diff. Pressure at Full Load	450 psi	3.1 mpa
Max. Diff, Press. across Bit	1,500 psi	10.3 mpa
Bit to Bend	28"	711 mm
Maximum Weight on Bit	6,000 lbs	2,700 kg
Maximum Bit Pull	30,000 lbs	13,000 kg
Bit Box Threads	2-3/8 Reg	
Top Connection	2-3/8 Reg	









288-5L-3 Predicted Build Rate (Degree/100ft)

ABH Angel	Slick Bearing Housing				Stabilized Bearing Housing			
	3 ½	3 7/8	4 ¼	4 ½	3 ½	3 7/8	4 ¼	4 ½
0.31					3.40	5.13	6.85	7.99
0.62	0.76				8.31	10.03	11.73	12.86
0.93	6.33	0.30			13.22	14.92	16.61	17.74
1.22	11.55	5.50			17.81	19.50	21.18	22.29
1.50	16.58	10.52	4.64	0.81	22.25	23.93	25.59	26.70
1.76	21.25	15.18	9.29	5.45	26.36	28.03	29.69	30.78
2.00	25.56	19.48	13.58	9.73	30.17	31.82	33.47	34.56
2.23	29.70	23.61	17.69	13.84	33.81	35.46	37.09	38.17
2.42	33.11	27.01	21.09	17.23	36.82	38.46	40.08	41.16
2.60	36.35	30.24	24.30	20.44	39.67	41.30	42.92	43.99
2.74	38.87	32.75	26.81	22.94	41.89	43.51	45.12	46.19
2.85	40.84	34.72	28.77	24.90	43.63	45.25	46.86	47.19
2.93	42.28	36.15	30.20	26.33	44.90	46.51	48.12	49.18
2.98	43.18	37.05	31.10	27.22	45.69	47.30	48.91	49.97
3.00	43.54	37.41	31.46	27.58	46.01	47.62	49.22	50.28

Revolution Per Gallon

Flow Rate	Rev./Gal (At Full Operating Load)
100	2.6

DIRECTIONAL DRILLING SERVICES
Positive Down Hole Motors Brochures
CAVO Technology Method

Model Number	Fishing Dimensions (in)																								
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Y'	Z
288-5L-3	2.9		4.9		18.9	40.9	81.9	7.5		130.3	1.9			24.7	14.7	79.5	1.8	1.8		2.4	22.1	1.9	2.5	2.2	2.2	2.9	
288-7L-4	2.9		4.9		18.9	40.9	81.9	7.5		130.3	1.9			24.7	14.7	79.5	1.8	1.8		2.4	22.1	1.9	2.5	2.2	2.2	2.9	
313-7L-4	3.1		4.9		18.9	40.9	81.9	7.5		130.3	1.9			24.7	14.7	79.5	1.8	1.8		2.4	22.1	1.9	2.5	2.2	2.2	2.9	
350-5L-3	3.5		6.3		21.5	49.6	83.5	9.1		142.1	2.3			30.6	15.7	80.3	2.4	2.4		30.9	28.1	2.5	3.1	2.8	2.8	3.5	
375-1L-4	3.8	4.1	6.9	8.5	26.7	56.9	82.7	9.6		149.2	2.5	6.5	0.4	36.0	18.5	78.7	2.5	2.6	1.3	33.3	30.2	2.8	3.5	3.0	3.0	3.8	
375-5L-3	3.8	4.1	6.9	8.5	26.7	56.9	82.7	9.6		149.2	2.5	6.5	0.4	36.0	18.5	78.7	2.5	2.6	1.3	33.3	30.2	2.8	3.5	3.0	3.0	3.8	
375-9L-4	3.8	4.1	6.9	8.5	26.7	56.9	82.7	9.6		149.2	2.5	6.5	0.4	36.0	18.5	78.7	2.8	2.6	1.3	33.3	30.2	2.8	3.5	3.0	3.0	3.8	
475-3L-4	4.7	5.4	7.9	13.8	29.6	70.7	100.3	11.3	6.9	182.4	3.0	7.9	0.6	40.0	28.3	96.1	2.8	3.3	1.7	44.6	41.1	3.3	4.4	4.0	3.7	4.7	33.6
475-3L-5	4.7	5.4	7.9	13.8	29.6	70.7	125.3	11.3	6.9	207.4	3.0	7.9	0.6	40.0	28.3	120.1	2.8	3.3	1.7	44.6	41.1	3.3	4.4	4.0	3.7	4.7	33.6
475-3L-6	4.7	5.4	7.9	13.8	29.6	70.7	150.4	11.3	6.9	232.4	3.0	7.9	0.6	40.0	28.3	144.1	2.8	3.3	1.7	44.6	41.1	3.3	4.4	4.0	3.7	4.7	33.6
475-5L-3	4.7	5.4	7.9	13.8	29.6	70.7	118.9	11.3	6.9	201.0	3.0	7.9	0.6	40.0	28.3	115.7	2.8	3.3	1.7	44.6	41.1	3.3	4.4	4.0	3.7	4.7	33.6
475-5L-4	4.7	5.4	7.9	13.8	29.6	70.7	100.3	11.3	6.9	182.4	3.0	7.9	0.6	40.0	28.3	96.1	2.8	3.3	1.7	44.6	41.1	3.3	4.4	4.0	3.7	4.7	33.6
475-5L-5	4.7	5.4	7.9	13.8	29.6	70.7	125.3	11.3	6.9	207.4	3.0	7.9	0.6	40.0	28.3	120.1	2.8	3.3	1.7	44.6	41.1	3.3	4.4	4.0	3.7	4.7	33.6
475-5L-6	4.7	5.4	7.9	13.8	29.6	70.7	150.4	11.3	6.9	232.4	3.0	7.9	0.6	40.0	28.3	144.1	2.8	3.3	1.7	44.6	41.1	3.3	4.4	4.0	3.7	4.7	33.6
475-7L-3	4.7	5.4	7.9	13.8	29.6	70.7	100.3	11.3	6.9	182.4	3.0	7.9	0.6	40.0	28.3	96.1	2.8	3.3	1.7	44.6	41.1	3.3	4.4	4.0	3.7	4.7	33.6
475-9L-3.6*	4.7	5.4	7.9	13.8	29.6	70.7	100.3	11.3	6.9	182.4	3.0	7.9	0.6	40.0	28.3	96.1	2.8	3.3	1.7	44.6	41.1	3.3	4.4	4.0	3.7	4.7	33.6
475-9L-4	4.7	5.4	7.9	13.8	29.6	70.7	100.3	11.3	6.9	182.4	3.0	7.9	0.6	40.0	28.3	96.1	2.8	3.3	1.7	44.6	41.1	3.3	4.4	4.0	3.7	4.7	33.6
475-9L-5*	4.7	5.4	7.9	13.8	29.6	70.7	125.3	11.3	6.9	207.4	3.0	7.9	0.6	40.0	28.3	120.1	2.8	3.3	1.7	44.6	41.1	3.3	4.4	4.0	3.7	4.7	33.6
475-9L-6.5*	4.7	5.4	7.9	13.8	29.6	70.7	150.4	11.3	6.9	207.4	3.0	7.9	0.6	40.0	28.3	144.1	2.8	3.3	1.7	44.6	41.1	3.3	4.4	4.0	3.7	4.7	33.6
550-5L-4	5.5	6.3	8.5	17.4	35.1	78.2	126.2	13.3	7.5	237.2	3.8	10.0	0.9	47.2	28.6	121.3	3.3	3.9	2.1	46.9	43.1	3.9	5.1	4.5	4.4	5.5	
650-5L-4	6.5	7.2	9.2	21.4	40.6	85.7	152.2	15.2	8.1	253.0	4.6	12.0	1.2	54.3	28.9	146.5	3.8	4.4	2.4	49.1	45.1	4.5	5.8	5.1	5.1	6.5	
650-5L-5	6.5	7.2	9.2	21.4	40.6	85.7	181.1	15.2	8.1	282.0	4.6	12.0	1.2	54.3	28.9	175.4	3.8	4.4	2.4	49.1	45.1	4.5	5.8	5.1	5.1	6.5	
650-5L-6	6.5	7.2	9.2	21.4	40.6	96.8	214.6	15.2	8.1	326.6	4.6	12.0	1.2	54.3	39.3	208.7	3.8	4.7	2.6	60.2	56.1	4.5	5.8	5.5	5.3	6.8	12.2
650-9L-3.7	6.5	7.2	9.2	21.4	40.6	96.8	214.6	15.2	8.1	326.6	4.6	12.0	1.2	54.3	39.3	208.7	3.8	4.7	2.6	60.2	56.1	4.5	5.8	5.5	5.3	6.8	12.2
650-9L-4	6.5	7.2	9.2	21.4	40.6	85.7	152.2	15.2	8.1	253.0	4.6	12.0	1.2	54.3	28.9	146.5	3.8	4.4	2.4	49.1	45.1	4.5	5.8	5.1	5.1	6.5	
675-3L-4	6.8	7.4	9.2	21.2	42.7	98.5	148.8	15.0	10.4	262.3	4.5	12.2	1.4	56.8	39.3	144.3	4.2	4.7	2.6	60.2	55.8	4.9	6.1	5.5	5.3	6.8	11.8
675-3L-4*	6.8	7.4	9.2	21.2	42.7	98.5	148.8	15.0	10.4	262.3	4.5	12.2	1.4	56.8	39.3	144.3	4.2	4.7	2.6	60.2	55.8	4.9	6.1	5.5	5.3	6.8	11.8

DIRECTIONAL DRILLING SERVICES
Positive Down Hole Motors Brochures
CAVO Technology Method

Model Number	Fishing Dimensions (in)																										
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Y'	Z
675-3L-5	6.8	7.4	9.2	21.2	42.7	98.5	181.5	15.0	10.4	295.0	4.5	12.2	1.4	56.8	39.3	175.6	4.2	4.7	2.6	60.2	55.8	4.9	6.1	5.5	5.3	6.8	11.8
675-3L-5*	6.8	7.4	9.2	21.2	42.7	98.5	181.5	15.0	10.4	295.0	4.5	12.2	1.4	56.8	39.3	175.6	4.2	4.7	2.6	60.2	55.8	4.9	6.1	5.5	5.3	6.8	11.8
675-5L-6	6.8	7.4	9.2	21.2	42.7	98.5	214.6	15.0	10.4	328.1	4.5	12.2	1.4	56.8	39.3	208.7	4.2	4.7	2.6	60.2	55.8	4.9	6.1	5.5	5.3	6.8	11.8
675-5L-4	6.8	7.4	9.2	21.2	42.7	98.5	148.8	15.0	10.4	262.3	4.5	12.2	1.4	56.8	39.3	144.3	4.2	4.7	2.6	60.2	55.8	4.9	6.1	5.5	5.3	6.8	11.8
675-5L-5	6.8	7.4	9.2	21.2	42.7	98.5	181.5	15.0	10.4	295.0	4.5	12.2	1.4	56.8	39.3	175.6	4.2	4.7	2.6	60.2	55.8	4.9	6.1	5.5	5.3	6.8	11.8
675-5L-6	6.8	7.4	9.2	21.2	42.7	98.5	214.6	15.0	10.4	328.1	4.5	12.2	1.4	56.8	39.3	208.7	4.2	4.7	2.6	60.2	55.8	4.9	6.1	5.5	5.3	6.8	11.8
675-9L-2	6.8	7.4	9.2	21.2	42.7	98.5	90.2	15.0	10.4	203.7	4.5	12.2	1.4	56.8	39.3	85.0	4.9	4.7	2.6	60.2	55.8	4.9	6.1	5.5	5.3	6.8	11.8
675-9L-4	6.8	7.4	9.2	21.2	42.7	98.5	175.2	15.0	10.4	203.7	4.5	12.2	1.4	56.8	39.3	170.1	4.9	4.7	2.6	60.2	55.8	4.9	6.1	5.5	5.3	6.8	11.8
775-5L-4	7.8	8.7	9.7	24.1	46.5	96.6	148.0	16.1	10.2	260.8	5.1	14.2	1.6	63.0	31.5	143.5	4.9	5.5	3.1	54.9	50.2	6.0	7.1	6.5	6.5	7.8	
775-5L-5	7.8	8.7	9.7	24.1	46.5	96.6	181.1	16.1	10.2	293.9	5.1	14.2	1.6	63.0	31.5	176.6	4.9	5.5	3.1	54.9	50.2	6.0	7.1	6.5	6.5	7.8	
775-5L-6	7.8	8.7	9.7	24.1	46.5	96.6	214.2	16.1	10.2	326.9	5.1	14.2	1.6	63.0	31.5	209.6	4.9	5.5	3.1	54.9	50.2	6.0	7.1	6.5	6.5	7.8	
775-9L-4	7.8	8.7	9.7	24.1	46.5	96.6	148.0	16.1	10.2	260.8	5.1	14.2	1.6	63.0	31.5	143.5	4.9	5.5	3.1	54.9	50.2	6.0	7.1	6.5	6.5	7.8	
800-1L-4	8.0	8.7	11.4	24.3	47.3	102.4	148	16.1	9.6	266.6	5.5	14.2	0.8	68.3	31.5	143.5	4.1	5.5	3.1	59.8	55.1	6.0	7.1	6.5	6.5	8.0	
800-5L-4	8.0	8.7	11.4	24.3	47.3	102.4	148	16.1	9.6	266.6	5.5	14.2	0.8	68.3	31.5	143.5	4.9	5.5	3.1	59.8	55.1	6.0	7.1	6.5	6.5	8.0	
800-5L-5	8.0	8.7	11.4	24.3	47.3	102.4	181.1	16.1	9.6	266.6	5.5	14.2	0.8	68.3	31.5	176.8	4.9	5.5	3.1	59.8	55.1	6.0	7.1	6.5	6.5	8.0	
800-5L-6	8.0	8.7	11.4	24.3	47.3	102.4	214.2	16.1	9.6	266.6	5.5	14.2	0.8	68.3	31.5	209.6	4.9	5.5	3.1	59.8	55.1	6.0	7.1	6.5	6.5	8.0	
800-9L-4	8.0	8.7	11.4	24.3	47.3	102.4	148	16.1	9.6	266.6	5.5	14.2	0.8	68.3	31.5	143.5	5.2	5.5	3.1	59.8	55.1	6.0	7.1	6.5	6.5	8.0	
850-3L-4	8.5	9.6	9.8	24.4	46.9	97.0	148.0	16.7	9.7	261.7	5.7	15.0	2.0	63.4	31.5	143.3	5.4	6.0	3.3	55.1	48.8	6.3	7.7	7.1	7.1	8.5	
850-3L-4*	8.5	9.6	9.8	24.4	46.9	97.0	148.0	16.7	9.7	261.7	5.7	15.0	2.0	63.4	31.5	143.3	5.4	6.0	3.3	55.1	48.8	6.3	7.7	7.1	7.1	8.5	
850-3L-5	8.5	9.6	9.8	24.4	46.9	97.0	181.1	16.7	9.7	294.8	5.7	15.0	2.0	63.4	31.5	176.4	5.4	6.0	3.3	55.1	48.8	6.3	7.7	7.1	7.1	8.5	
850-3L-5*	8.5	9.6	9.8	24.4	46.9	97.0	181.1	16.7	9.7	294.8	5.7	15.0	2.0	63.4	31.5	176.4	5.4	6.0	3.3	55.1	48.8	6.3	7.7	7.1	7.1	8.5	
850-3L-6	8.5	9.6	9.8	24.4	46.9	97.0	214.2	16.7	9.7	327.9	5.7	15.0	2.0	63.4	31.5	209.4	5.4	6.0	3.3	55.1	48.8	6.3	7.7	7.1	7.1	8.5	
850-3L-6*	8.5	9.6	9.8	24.4	46.9	97.0	214.2	16.7	9.7	327.9	5.7	15.0	2.0	63.4	31.5	209.4	5.4	6.0	3.3	55.1	48.8	6.3	7.7	7.1	7.1	8.5	
850-5L-4	8.5	9.6	9.8	24.4	46.9	97.0	148.0	16.7	9.7	261.7	5.7	15.0	2.0	63.4	31.5	143.3	5.4	6.0	3.3	55.1	48.8	6.3	7.7	7.1	7.1	8.5	
850-5L-5	8.5	9.6	9.8	24.4	46.9	97.0	181.1	16.7	9.7	294.8	5.7	15.0	2.0	63.4	31.5	176.4	5.4	6.0	3.3	55.1	48.8	6.3	7.7	7.1	7.1	8.5	
850-5L-6	8.5	9.6	9.8	24.4	46.9	97.0	214.2	16.7	9.7	327.9	5.7	15.0	2.0	63.4	31.5	209.4	5.4	6.0	3.3	55.1	48.8	6.3	7.7	7.1	7.1	8.5	
963-3L-4	9.6	10.9	10.2	25.6	48.5	104.6	153.1	24.6	9.3	282.4	6.5	15.7	2.6	65.0	36.6	147.6	5.9	6.5	3.5	61.5	56.1	6.9	8.9	7.9	7.5	9.6	13.4

DIRECTIONAL DRILLING SERVICES
Positive Down Hole Motors Brochures
CAVO Technology Method

Model Number	Fishing Dimensions (in)																										
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Y'	Z
963-3L-4*	9.6	10.9	10.2	25.6	48.5	104.6	153.1	24.6	9.3	282.4	6.5	15.7	2.6	65.0	36.6	147.6	5.9	6.5	3.5	61.5	56.1	6.9	8.9	7.9	7.5	9.6	13.4
963-3L-5	9.6	10.9	10.2	25.6	48.5	104.6	186.2	24.6	9.3	315.4	6.5	15.7	2.6	65.0	36.6	180.7	5.9	6.5	3.5	61.5	56.1	6.9	8.9	7.9	7.5	9.6	13.4
963-3L-5*	9.6	10.9	10.2	25.6	48.5	104.6	186.2	24.6	9.3	315.4	6.5	15.7	2.6	65.0	36.6	180.7	5.9	6.5	3.5	61.5	56.1	6.9	8.9	7.9	7.5	9.6	13.4
963-3L-6	9.6	10.9	10.2	25.6	48.5	104.6	219.3	24.6	9.3	348.5	6.5	15.7	2.6	65.0	36.6	213.8	5.9	6.5	3.5	61.5	56.1	6.9	8.9	7.9	7.5	9.6	13.4
963-5L-4	9.6	10.9	10.2	25.6	48.5	104.6	153.1	24.6	9.3	282.4	6.5	15.7	2.6	65.0	36.6	147.6	5.9	6.5	3.5	61.5	56.1	6.9	8.9	7.9	7.5	9.6	13.4
963-5L-5	9.6	10.9	10.2	25.6	48.5	104.6	186.2	24.6	9.3	315.4	6.5	15.7	2.6	65.0	36.6	180.7	5.9	6.5	3.5	61.5	56.1	6.9	8.9	7.9	7.5	9.6	13.4
963-5L-6	9.6	10.9	10.2	25.6	48.5	104.6	219.3	24.6	9.3	348.5	6.5	15.7	2.6	65.0	36.6	213.8	5.9	6.5	3.5	61.5	56.1	6.9	8.9	7.9	7.5	9.6	13.4
1125-3L-4	11.25	12.4	14.2	31.4	57.5	126	227	21.7	11.7	374.8	8.2	18.0	3.0	82.3	39.6	219.3	6.7	7.1	7.1	74.4	68.5	7.9	10.1	8.8	8.8	11.25	

Postive Down hole Motors
Motor Specifications Tables

Motor Size	Motor Type	Tool OD	Number Of Lob	Number of Stages	Weight Lbs/Kg	Legnth	Flow Rate	Bit Speed At Full Load	Maximum Torque	Maximum Power	Diff.Pressure At Full	Max.Diff,Press.across	Bit To Bend	Maximum Weight on Bit	Maximum Bit Pull	Bit Box Threads	Top Connection	Revolution Per Gallon
4-3/4"	TL-DRILL-475-2L-7	4.75"/120 mm	2:3	7	1155 lbs/524 kg	26.5 ft/8.07 m	100-250	195-450 rpm	1825 ft-lbs/2474 N	156 hp/116 kw	600 psi/4.1 mpa	1500 psi/10.3 mpa	46"/1168 mm	25000/11300 kg	100000/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	1.4
	TL-DRILL-475-3L-4	4.75"/120 mm	3:4	4	1074 lbs/487 kg	20.5 ft/6.25 m	100-250	130-350 rpm	2230 ft-lbs/3032 N-m	148 hp/110 kw	600 psi/4.1 mpa	1500 psi/10.3 mpa	46"/1168 mm	25000/11300 kg	100000/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	1.4
	TL-DRILL-475-3L-5	4.75"/120 mm	3:4	5	1270 lbs/576 kg	24.3 ft/7.39 m	100-250	100-250 rpm	2787 ft-lbs/3779 N-m	133 hp/99 kw	750 PSI/5.2 mpa	1500 psi/10.3 mpa	46"/1168 mm	25000/11300 kg	100000/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	1.4
	TL-DRILL-475-2L-6	4.75"/120 mm	3:4	6	1471 lbs/667 kg	28.1 ft/8.56 m	100-250	175-390 rpm	2800 ft-lbs/3796 N-m	208 hp/155 kw	900 psi/6.2 mpa	1500 psi/10.3 mpa	46"/1168 mm	25000/11300 kg	100000/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	1.4
	TL-DRILL-475-3L-6	4.75"/120 mm	3:4	6	1471 lbs/667 kg	28.1 ft/8.56 m	100-250	110-270 rpm	3344 ft-lbs/4534 N-m	172 hp/128 kw	900 psi/6.2 mpa	1500 psi/10.3 mpa	46"/1168 mm	25000/11300 kg	100000/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	1.4
	TL-DRILL-475-5L-3	4.75"/120 mm	5:6	3	873 lbs/396 kg	16.7 ft/5.08 m	100-250	55-155 rpm	2110 ft-lbs/2861 N-m	62 hp/46 kw	450 psi/3.1 mpa	1500 psi/10.3 mpa	46"/1168 mm	25000/11300 kg	100000/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	0.7
	TL-DRILL-475-5L-4	4.75"/120 mm	5:6	4	1074/487 kg	20.5 ft/6.25 m	100-250	70-175 rpm	2810 ft/3810 N	94 hp/70 kw	600 psi/4.1 mpa	1500 psi/10.3 mpa	46"/1168 mm	25000/11300 kg	100000/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	0.7
	TL-DRILL-475-5L-5	4.75"/120 mm	5:6	5	1270 lbs/576 kg	24.3 ft/7.39 m	100-250	90-195 rpm	3515 ft/4766 N	130 HP/97 KW	750 PSI/5.2 mpa	1500 psi/10.3 mpa	46"/1168 mm	25000/11300 kg	100000/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	0.7
	TL-DRILL-475-5L-6	4.75"/120 mm	5:6	6	1471 lbs/667 kg	28.1 ft/8.56 m	100-250	110-195 rpm	4220 ft/5722 N	156 hp/116 kw	900 psi/6.2 mpa	1500 psi/10.3 mpa	46"/1168 mm	25000/11300 kg	100000/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	0.7
	TL-DRILL-475-7L-3	4.75"/120 mm	7:8	3	873 lbs/396 kg	16.7 ft/5.08 m	100-250	40-150 rpm	2835 ft/3844 N	81 hp/60 kw	450 psi/3.1 mpa	1500 psi/4.1 mpa	46"/1168 mm	25000/11300 kg	100000/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	0.6
	TL-DRILL-475-9L-3.6	4.75"/120 mm	9:10	3.6	1100 lbs/499 kg	18.5 ft/5.64 m	100-250	58-160 rpm	3868 ft/5244 N	118 hp/88 kw	450 psi/3.1 mpa	1500 psi/10.3 mpa	46"/1168 mm	25000/11300 kg	100000/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	0.64
	TL-DRILL-475-9L-4	4.75"/120 mm	9:10	4	1100 lbs/499 kg	20.5 ft/6.25 m	100-250	75-180 rpm	4960 ft/6725 N	169 hp/126 kw	600 psi/4.1 mpa	1500 psi/10.3 mpa	46"/1168 mm	25000/11300 kg	100000/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	0.7
	TL-DRILL-475-9L-5	4.75"/120 mm	9:10	5	1343 lbs/609 kg	22.5 ft/6.88 m	100-250	78-185 rpm	4280 ft/5802 N	150 hp/111 kw	750 PSI/5.2 mpa	1500 psi/10.3 mpa	46"/1168 mm	25000/11300 kg	100000/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	0.64
	TL-DRILL-475-9L-6.5	4.75"/120 mm	9:10	6.5	1260 lbs/560 kg	27.0 ft/8.23 m	100-250	88-190 rpm	5830 ft/7904 N	210 HP/137 kw	900 psi/6.2 mpa	1500 psi/10.3 mpa	46"/1168 mm	25000/11300 kg	100000/45300 kg	3-1/2 Reg	3-1/2 Reg	0.64
6-1/2"	TL-DRILL-650-5L-4	6.5"/165 mm	5:6	4	1753 lbs/795 kg	21.1 ft/6.43 m	200-500	75-180 rpm	4910 ft/6657 N	168 hp/125 kw	600 psi/4.1 mpa	1500 psi/10.3 mpa	76"/1930 mm	50000/22000 kg	200000/90000 kg	4-1/2 Reg	4-1/4 Reg / 4-1/2 XH	0.36
	TL-DRILL-650-5L-5	6.5"/165 mm	5:6	5	2006 lbs/7.16 kg	23.5 ft/7.16 m	200-500	75-180 rpm	6625 ft/8982 N	227 hp/169 kw	750 psi/5.2 mpa	1500 psi/10.3 mpa	76"/1930 mm	50000/22000 kg	200000/90000 kg	4-1/2 Reg	4-1/4 Reg / 4-1/2 XH	0.36
	TL-DRILL-650-5L-6	6.5"/165 mm	5:6	6	2266 lbs/1028 kg	26.3 ft/8.00 m	200-500	75-180 rpm	6900 ft/9355 N-m	236 hp/167 kw	900 psi/6.2 mpa	1500 psi/10.3 mpa	76"/1930 mm	50000/22000 kg	200000/90000 kg	4-1/2 Reg	4-1/4 Reg / 4-1/2 XH	0.14
	TL-DRILL-650-9L-3.7	6.5"/165 mm	9:10	3.7	1753 lbs/795 kg	26.3 ft/8.00 m	200-500	20-70 rpm	12000 ft/16270 N	160 hp/119 kw	450 psi/3.1 mpa	1500 psi/10.3 mpa	76"/1930 mm	50000/22000 kg	200000/90000 kg	4-1/2 Reg	4-1/4 Reg / 4-1/2 XH	0.14
	TL-DRILL-650-9L-4	6.5"/165 mm	9:10	4	1753 lbs/795 kg	21.1 ft/6.43 m	200-500	50-180 rpm	10900 ft/14788 N	373 hp/279 kw	600 psi/4.1 mpa	1500 psi/10.3 mpa	76"/1930 mm	50000/22000 kg	200000/90000 kg	4-1/2 Reg	4-1/4 Reg / 4-1/2 XH	0.36
6-3/4"	TL-DRILL-675-2L-7	6.75"/172 mm	2:3	7	2034 lbs/908 kg	25.31 ft/7.716 m	300-600	250-500 rpm	2700 ft/3661 N-m	257 hp/191.7 kw	900 psi/6.2 mpa	1500 psi/10.3 mpa	76"/1930 mm	50000/22680 kg	225000/1000000	4-1/2 Reg	4-1/2 Reg	0.83
	TL-DRILL-675-3L-4	6.75"/172 mm	3:4	4	1612 lbs/731 kg	21.1 ft/6.40 m	300-625	100-300 rpm	4854 ft-6581 N-m	277 hp/207 kw	600 psi/4.1 mpa	1500 psi/10.3 mpa	76"/1930 mm	75000/34000 kg	225000/100000	4-1/2 Reg	4-1/2 Reg	0.4
	TL-DRILL-675-3L-5	6.75"/172 mm	3:4	5	1834 lbs/832 kg	24.0 ft/7.3 m	300-625	110-260 rpm	6210 ft/8420 N-m	307 hp/229 kw	750 psi/5.2 mpa	1500 psi/10.3 mpa	76"/1930 mm	75000/34000 kg	225000/100000	4-1/2 Reg	4-1/2 Reg	0.4
	TL-DRILL-675-2L-6	6.75"/172 mm	3:4	6	2880 lbs/1306 kg	28.0 ft/8.53 m	250-500	120-320 rpm	4700 ft/6372 N-m	286 hp/213 kw	900 psi/6.2 mpa	1500 psi/10.3 mpa	76"/1930 mm	75000/34000 kg	225000/100000	4-1/2 Reg	4-1/2 Reg	0.5
	TL-DRILL-675-3L-6	6.75"/172 mm	3:4	6	2880 lbs/1306 kg	28.0 ft/8.53 m	250-600	90-210 rpm	7900 ft/10711 N	316 hp/236 kw	900 psi/6.2 mpa	1500 psi/10.3 mpa	76"/1930 mm	75000/34000 kg	225000/100000	4-1/2 Reg	4-1/2 Reg	0.36
	TL-DRILL-675-5L-4	6.75"/172 mm	5:6	4	2156 lbs/978 kg	21.75 ft/6.63 m	250-600	75-120 rpm	5535 ft/7500 N-m	158 hp/118 kw	600 psi/4.1 mpa	1500 psi/10.3 mpa	76"/1930 mm	75000/34000 kg	225000/100000	4-1/2 Reg	4-1/2 Reg	0.3
	TL-DRILL-675-5L-5	6.75"/172 mm	5:6	5	2517 lbs/1142 kg	24.6 ft/7.49 m	250-600	90-190 rpm	6690 ft/9070 N-m	241 hp/181 kw	750 psi/5.2 mpa	1500 psi/10.3 mpa	76"/1930 mm	75000/34000 kg	225000/100000	4-1/2 Reg	4-1/2 Reg	0.3
	TL-DRILL-675-5L-6	6.75"/172 mm	5:6	6	2878 lbs/1305 kg	27.4 ft/8.36 m	250-600	100-200 rpm	7840 ft/10630 N-	298 hp/222 kw	900 psi/6.2 mpa	1500 psi/10.3 mpa	76"/1930 mm	75000/34000 kg	225000/100000	4-1/2 Reg	4-1/2 Reg	0.3
	TL-DRILL-675-9L-2	6.75"/172 mm	9:10	2	1795 lbs/814 kg	17.0 ft/5.18 m	250-600	50-180 rpm	8000 ft/10847 N	274 hp/204 kw	300 psi/2.1 mpa	1500 psi/10.3 mpa	76"/1930 mm	75000/34000 kg	225000/100000	4-1/2 Reg	4-1/2 Reg	0.3
	TL-DRILL-675-9L-4	6.75"/172 mm	9:10	4	2135 lbs/968 kg	22.5 ft/6.86 m	250-600	50-180	12400 ft/16812 N	425 hp/317 kw	600 psi/4.1 mpa	1500 psi/10.3 mpa	76"/1930 mm	75000/34000 kg	225000/100000	4-1/2 Reg	4-1/2 Reg	0.3
8-1/2"	TL-DRILL-850-3L-4	8.5"/216 mm	3:4	4	3258 lbs/1477 kg	23.4 ft/7.1 m	380-1200	110-250 rpm	10008 ft/13569 N-m	476 hp/355 kw	600 psi/4.1 mpa	1500 psi/10.3 mpa	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.21
	TL-DRILL-850-3L-4	8.5"/216 mm	3:4	4	3258 lbs/1477 kg	23.4 ft/7.1 m	380-1200	82-250 rpm	9980 ft-lbs/13531 N-m	481 hp-359 kw	600 psi/4.1 mpa	1500 psi/10.3 mpa	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.21
	TL-DRILL-850-3L-5	8.5"/216 mm	3:4	5	3482 lbs/1580 kg	26.32 ft/8.0 m	380-1200	110-250 rpm	13180 ft-lbs/17870 N-m	627 hp-467 kw	750 psi/5.2 mpa	1500 psi/10.3 mpa	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.21
	TL-DRILL-850-3L-5	8.5"/216 mm	3:4	5	3482 lbs/1580 kg	26.32 ft/8.0 m	380-1200	82-250	11655 ft-lbs/153802 N-m	555 hp/413 kw	750 psi/5.2 mpa	1500 psi/10.3 mpa	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.21
	TL-DRILL-850-2L-6	8.5"/216 mm	3:4	6	3706 lbs/1628 kg	29.23 ft/8.9 m	430-1050	100-245 rpm	12300 ft-lbs/16676 N-m	574 hp/427 kw	900 psi/6.2 mpa	1500 psi/10.3 mpa	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.21
	TL-DRILL-850-3L-6	8.5"/216 mm	3:4	6	3706 lbs/1628 kg	29.23 ft/8.9 m	430-1050	90-210 rpm	16345 ft-lbs/22160 N-m	653 hp/487 kw	900 psi/6.2 mpa	1500 psi/10.3 mpa	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.21
	TL-DRILL-850-3L-6	8.5"/216 mm	3:4	6	3706 lbs/1628 kg	29.23 ft/8.9 m	380-1200	82-250 rpm	13330 ft-lbs/18070 N-m	653 hp/487 kw	900 psi/6.2 mpa	1500 psi/10.3 mpa	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.21
	TL-DRILL-850-5L-4	8.5"/216 mm	5:6	4	3637 lbs/1650 kg	21.8 ft/6.65 m	400-1000	80-180 rpm	116555 ft-lbs/15800 N-m	399 hp/298 kw	600 psi/4.1 mpa	1500 psi/10.3 mpa	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.18
	TL-DRILL-850-5L-5	8.5"/216 mm	5:6	5	3861 lbs/1752 kg	24.6 ft/7.49 m	400-1000	80-180 rpm	14460 ft-lbs/19600 N-m	495 hp/369 kw	750 psi/5.2 mpa	1500 psi/10.3 mpa	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.18
	TL-DRILL-850-5L-6	8.5"/216 mm	5:6	6	4085 lbs/1854 kg	27.3 ft/8.33 m	400-1000	80-180 rpm	17260 ft-lbs/23400 N-m	592 hp/441 kw	900 psi/6.2 mpa	1500 psi/10.3 mpa	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.18
9-5/8"	TL-DRILL-963-2L-7	9.625"/244 mm	2:3	7	5257 lbs/2347 kg	28.30 ft/8.34 m	500-1200	285-569 rpm	4508 ft-lbs/6112 N-m	488.4 hp/364.2 kw	880 psi/6.0 mpa	1500 psi/10.3 mpa	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.47
	TL-DRILL-963-3L-4	9.625"/244 mm	3:4	4	4655 lbs/2111 kg	26.42 ft/9.07 m	500-1200	100-260 rpm	13782 ft-lbs/18686 N-m	656 hp/489 kw	600 psi/4.1 mpa	1500 psi/10.3 mpa	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.21
	TL-DRILL-963-5L-4	9.625"/244 mm	5:6	4	4695 lbs/2,1 Kg	26.42 ft/9.07 m	450-1100	75-185 rpm	12207.35 ft-lbs/16551 N-m	430 hp/321 kw	600 psi/4.1 mpa	1500 psi/10.3 mpa	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.21
	TL-DRILL-963-3L-5	9.625"/244 mm	3:4	5	5040 lbs/2304 kg	29.75 ft/9.07 mm	500-1200	100-250 rpm	14463 ft-lbs/19609 N-m	688 hp/513 kw	750 psi/5.2 mpa	1500 psi/10.3 mpa	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.21
	TL-DRILL-963-3L-5	9.625"/244 mm	3:4	5	5040 lbs/2304 kg	29.75 ft/9.07 mm	500-1200	100-250 rpm	16805 ft-lbs/22785 N-m	800 hp/597 kw	750 PSI/5.2 mpa	1500 psi/10.3 mpa	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.21
	TL-DRILL-963-2L-6	9.625"/244 mm	3:4	6	5477 lbs/2485 kg	29.50 ft/8.99 m	500-1200	280-570 rpm	8200 ft-lbs/11118 N-m	890 hp/664 kw	900 psi/6.2 mpa	1500 psi/10.3 mpa	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.21
	TL-DRILL-963-3L-6	9.625"/244 mm	3:4	6	5477 lbs/2485 kg	29.50 ft/8.99 m	500-1200	125-250 rpm	10800 ft-lbs/20068 N-m	514 hp/393.7 kw	900 psi/6.2 mpa	1500 psi/10.3 mpa	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.21
	TL-DRILL-963-5L-4	9.625"/244 mm	5:6	4	4695 lbs/2,1 Kg	24.0 ft/7.3 m	500-1200	80-180 rpm	16155 ft-lbs/21900 N-m	553 hp/412 kw	600 psi/4.1 mpa	1500 psi/10.3 mpa	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.21
	TL-DRILL-963-25L-5	9.625"/244 mm	5:6	5	5080 lbs/2305 kg	29.75 ft/9.07 mm	500-1200	80-185 rpm	16915 ft-lbs/22935 N	595.8 hp/444 kw	750 psi/5.2 mpa	1500 psi/10.3 mpa	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.15
	TL-DRILL-963-5L-6	9.625"/244 mm	5:6	6	5477 lbs/2485 kg	29.5 ft/8.99 mm	500-1200	80-180 rpm	231000 ft-lbs/31319 N-m	792 hp/590 kw	900 psi/6.2 mpa	1500 psi/10.3 mpa	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.15
11-1/4"	TL-DRILL-1125-3L-4	11.25"/286 mm	3:4	4	7370 lbs/3350 kg	32.1 ft/9.79 m	1000-1500	100-180	17500 ft-lbs/23727 N-m	600 hp/447 kw	600 psi/4.1 mpa	1500 psi/10.3 mpa	89"/2260 mm	120000 lbs/55000 kg	550000 lbs/250000 kg	7-5/8" Reg	7-5/8" Reg	0.12

TL-Drill Measurment

Motor Size	Motor Type	Tool OD	Bit To Bend	Maximum Weight on Bit	Maximum Bit Pull	Bit Box Threads	Top Connection	Revolution Per Gallon
4-3/4"	TL-DRILL-475-2L-7	4.75"/120 mm	46"/1168 mm	25000lbs/11300 kg	100000lbs/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	1.4
	TL-DRILL-475-3L-4	4.75"/120 mm	46"/1168 mm	25000lbs/11300 kg	100000lbs/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	1.4
	TL-DRILL-475-3L-5	4.75"/120 mm	46"/1168 mm	25000lbs/11300 kg	100000lbs/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	1.4
	TL-DRILL-475-2L-6	4.75"/120 mm	46"/1168 mm	25000lbs/11300 kg	100000lbs/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	1.4
	TL-DRILL-475-3L-6	4.75"/120 mm	46"/1168 mm	25000lbs/11300 kg	100000lbs/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	1.4
	TL-DRILL-475-5L-3	4.75"/120 mm	46"/1168 mm	25000lbs/11300 kg	100000lbs/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	0.7
	TL-DRILL-475-5L-4	4.75"/120 mm	46"/1168 mm	25000lbs/11300 kg	100000lbs/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	0.7
	TL-DRILL-475-5L-5	4.75"/120 mm	46"/1168 mm	25000lbs/11300 kg	100000lbs/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	0.7
	TL-DRILL-475-5L-6	4.75"/120 mm	46"/1168 mm	25000lbs/11300 kg	100000lbs/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	0.7
	TL-DRILL-475-7L-3	4.75"/120 mm	46"/1168 mm	25000lbs/11300 kg	100000lbs/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	0.6
	TL-DRILL-475-9L-3.6	4.75"/120 mm	46"/1168 mm	25000lbs/11300 kg	100000lbs/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	0.64
	TL-DRILL-475-9L-4	4.75"/120 mm	46"/1168 mm	25000lbs/11300 kg	100000lbs/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	0.7
	TL-DRILL-475-9L-5	4.75"/120 mm	46"/1168 mm	25000lbs/11300 kg	100000lbs/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	0.64
	TL-DRILL-475-9L-6.5	4.75"/120 mm	46"/1168 mm	25000lbs/11300 kg	100000lbs/45300 kg	3-1/2 Reg	3-1/2 Reg/3-1/2 IF	0.64
6-3/4"	TL-DRILL-675-2L-7	6.75"/172 mm	76"/1930 mm	50000lbs/22680 kg	225000lbs/1000000 Kg	4-1/2 Reg	4-1/2 Reg/4-1/2 XH	0.83
	TL-DRILL-675-3L-4	6.75"/172 mm	76"/1930 mm	75000 lbs/34000 kg	225000lbs/1000000 Kg	4-1/2 Reg	4-1/2 Reg/4-1/2 XH	0.4
	TL-DRILL-675-3L-5	6.75"/172 mm	76"/1930 mm	75000 lbs/34000 kg	225000lbs/1000000 Kg	4-1/2 Reg	4-1/2 Reg/4-1/2 XH	0.4
	TL-DRILL-675-2L-6	6.75"/172 mm	76"/1930 mm	75000 lbs/34000 kg	225000lbs/1000000 Kg	4-1/2 Reg	4-1/2 Reg/4-1/2 XH	0.5
	TL-DRILL-675-3L-6	6.75"/172 mm	76"/1930 mm	75000 lbs/34000 kg	225000lbs/100000 kg	4-1/2 Reg	4-1/2 Reg/4-1/2 XH	0.36
	TL-DRILL-675-5L-4	6.75"/172 mm	76"/1930 mm	75000 lbs/34000 kg	225000lbs/100000 kg	4-1/2 Reg	4-1/2 Reg/4-1/2 XH	0.3
	TL-DRILL-675-5L-5	6.75"/172 mm	76"/1930 mm	75000 lbs/34000 kg	225000lbs/100000 kg	4-1/2 Reg	4-1/2 Reg/4-1/2 XH	0.3
	TL-DRILL-675-5L-6	6.75"/172 mm	76"/1930 mm	75000 lbs/34000 kg	225000lbs/100000 kg	4-1/2 Reg	4-1/2 Reg/4-1/2 XH	0.3
	TL-DRILL-675-9L-2	6.75"/172 mm	76"/1930 mm	75000 lbs/34000 kg	225000lbs/100000 kg	4-1/2 Reg	4-1/2 Reg/4-1/2 XH	0.3
	TL-DRILL-675-9L-4	6.75"/172 mm	76"/1930 mm	75000 lbs/34000 kg	225000lbs/100000 kg	4-1/2 Reg	4-1/2 Reg/4-1/2 XH	0.3
8-1/2"	TL-DRILL-850-3L-4	8.5"/216 mm	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.21
	TL-DRILL-850-3L-4	8.5"/216 mm	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.21
	TL-DRILL-850-3L-5	8.5"/216 mm	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.21
	TL-DRILL-850-3L-5	8.5"/216 mm	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.21
	TL-DRILL-850-2L-6	8.5"/216 mm	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.21
	TL-DRILL-850-3L-6	8.5"/216 mm	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.21
	TL-DRILL-850-3L-6	8.5"/216 mm	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.21
	TL-DRILL-850-5L-4	8.5"/216 mm	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.18
	TL-DRILL-850-5L-5	8.5"/216 mm	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.18
	TL-DRILL-850-5L-6	8.5"/216 mm	86"/2179 mm	85000 lbs/38000 kg	360000 lbs/160000 kg	6-5/8 Reg	6-5/8 Reg	0.18
9-5/8"	TL-DRILL-963-2L-7	9.625"/244 mm	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.47
	TL-DRILL-963-3L-4	9.625"/244 mm	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.21
	TL-DRILL-963-5L-4	9.625"/244 mm	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.21
	TL-DRILL-963-3L-5	9.625"/244 mm	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.21
	TL-DRILL-963-3L-5	9.625"/244 mm	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.21
	TL-DRILL-963-2L-6	9.625"/244 mm	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.21
	TL-DRILL-963-3L-6	9.625"/244 mm	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.21
	TL-DRILL-963-5L-4	9.625"/244 mm	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.21
	TL-DRILL-963-25L-5	9.625"/244 mm	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.15
	TL-DRILL-963-5L-6	9.625"/244 mm	95"/2413 mm	90000 lbs/41000 kg	480000 lbs/210000 kg	6-5/8" Reg/7-5/8" Reg	6-5/8" Reg/7-5/8" Reg	0.15
11-1/4"	TL-DRILL-1125-3L-4	11.25"/286 mm	89"/2260 mm	120000 lbs/55000 kg	550000 lbs/250000 kg	7-5/8" Reg	7-5/8" Reg	0.12